The American Journal of Surgery

EDITED BY THURSTON SCOTT WELTON, M.D.

May 1944

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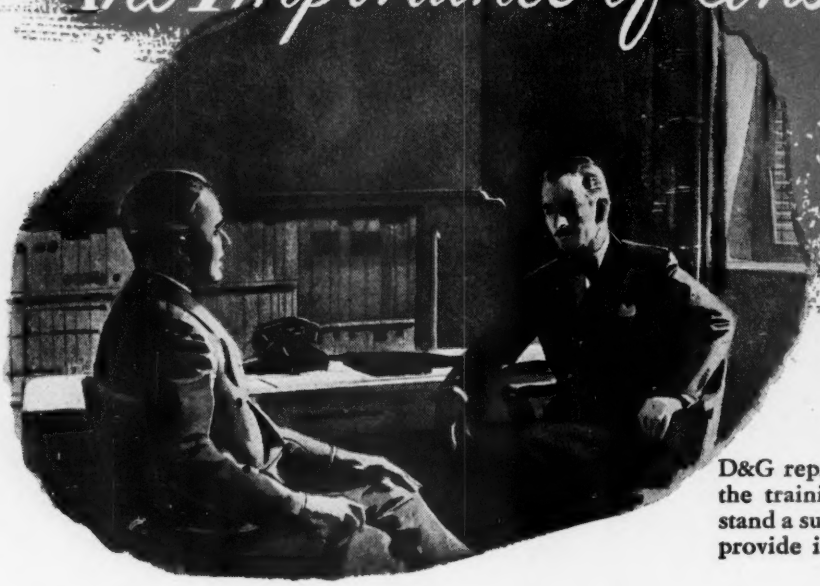

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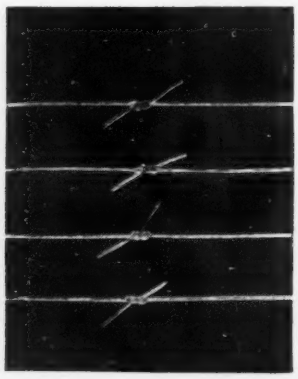

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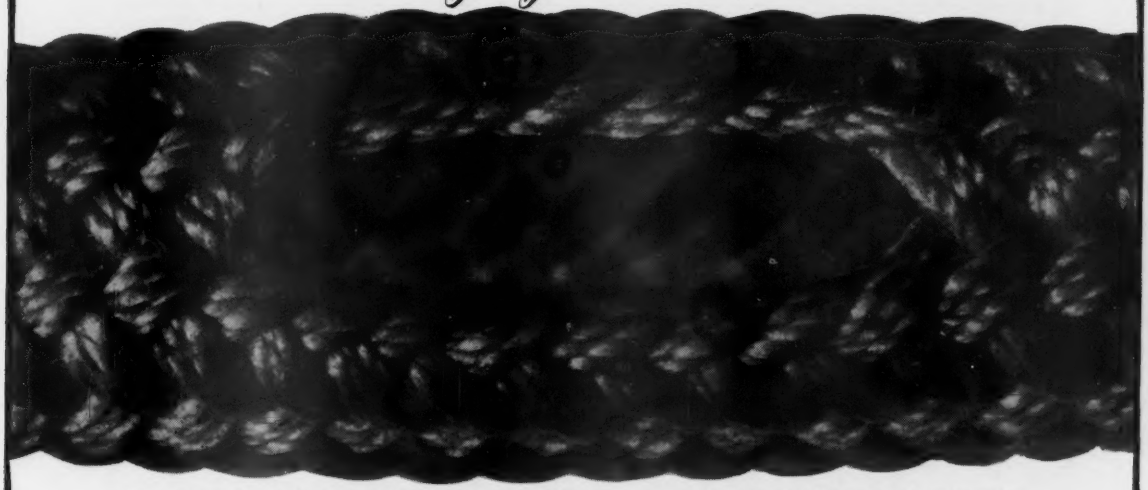

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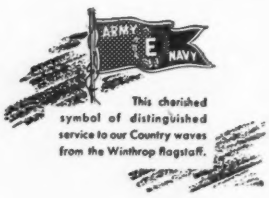

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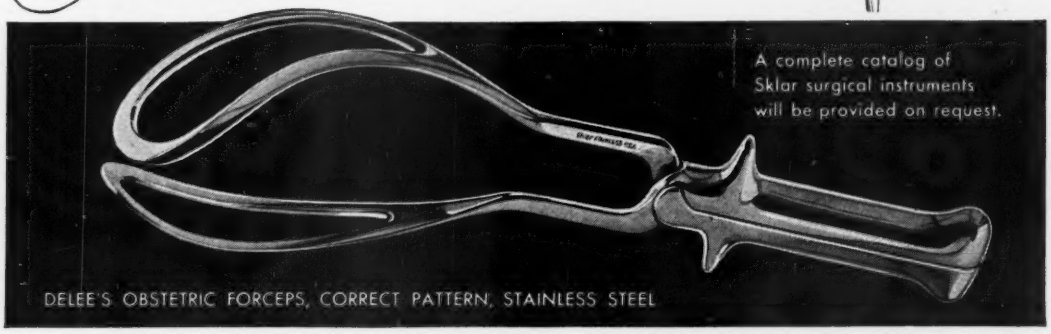

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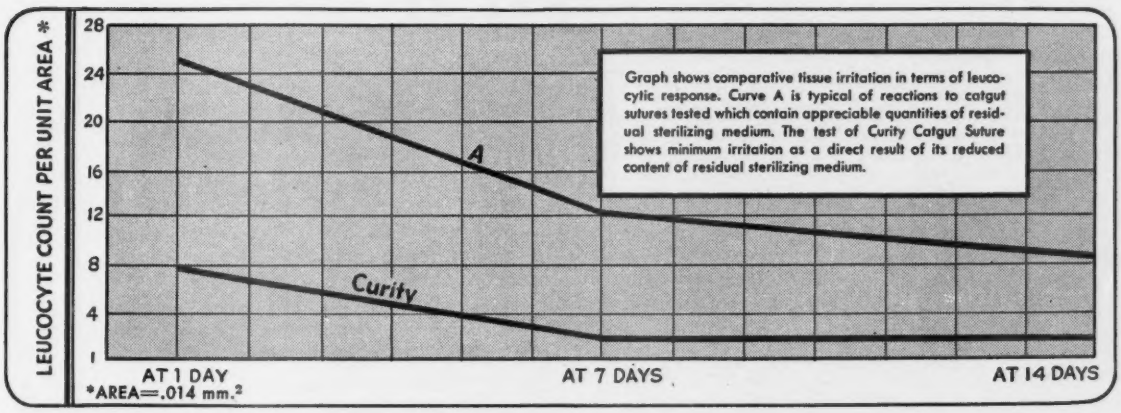
LEUCOCYTE COUNT PER UNIT AREA *
28
24
20
16
12
8
4
1
A
Curity
Graph shows comparative tissue irritation in terms of leucocytic response. Curve A is typical of reactions to catgut sutures tested which contain appreciable quantities of residual sterilizing medium. The test of Curity Catgut Suture shows minimum irritation as a direct result of its reduced content of residual sterilizing medium.
AT 1 DAY
AT 7 DAYS
AT 14 DAYS
*AREA=.014 mm.²

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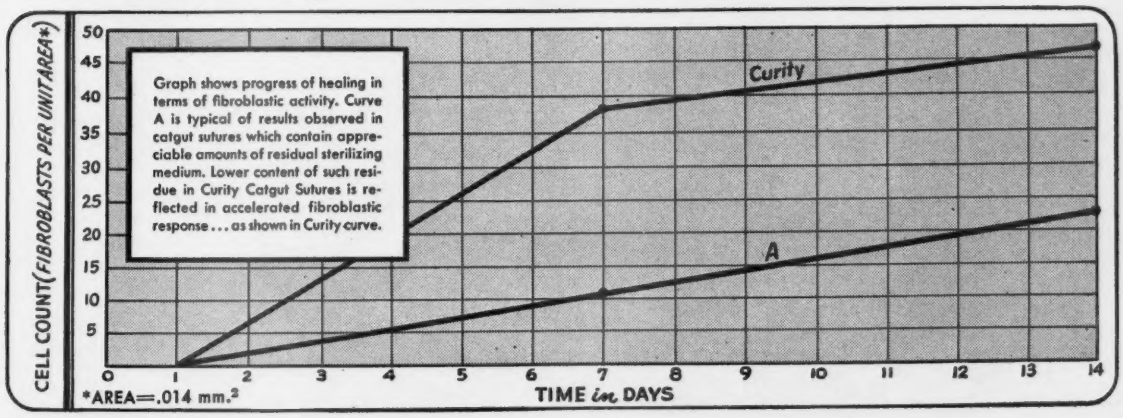
CELL COUNT (FIBROBLASTS PER UNIT AREA*)
50
45
40
35
30
25
20
15
10
5
Graph shows progress of healing in terms of fibroblastic activity. Curve A is typical of results observed in catgut sutures which contain appreciable amounts of residual sterilizing medium. Lower content of such residue in Curity Catgut Sutures is reflected in accelerated fibroblastic response ... as shown in Curity curve.
Curity
A
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14
*AREA=.014 mm.²
TIME in DAYS

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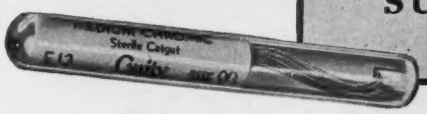

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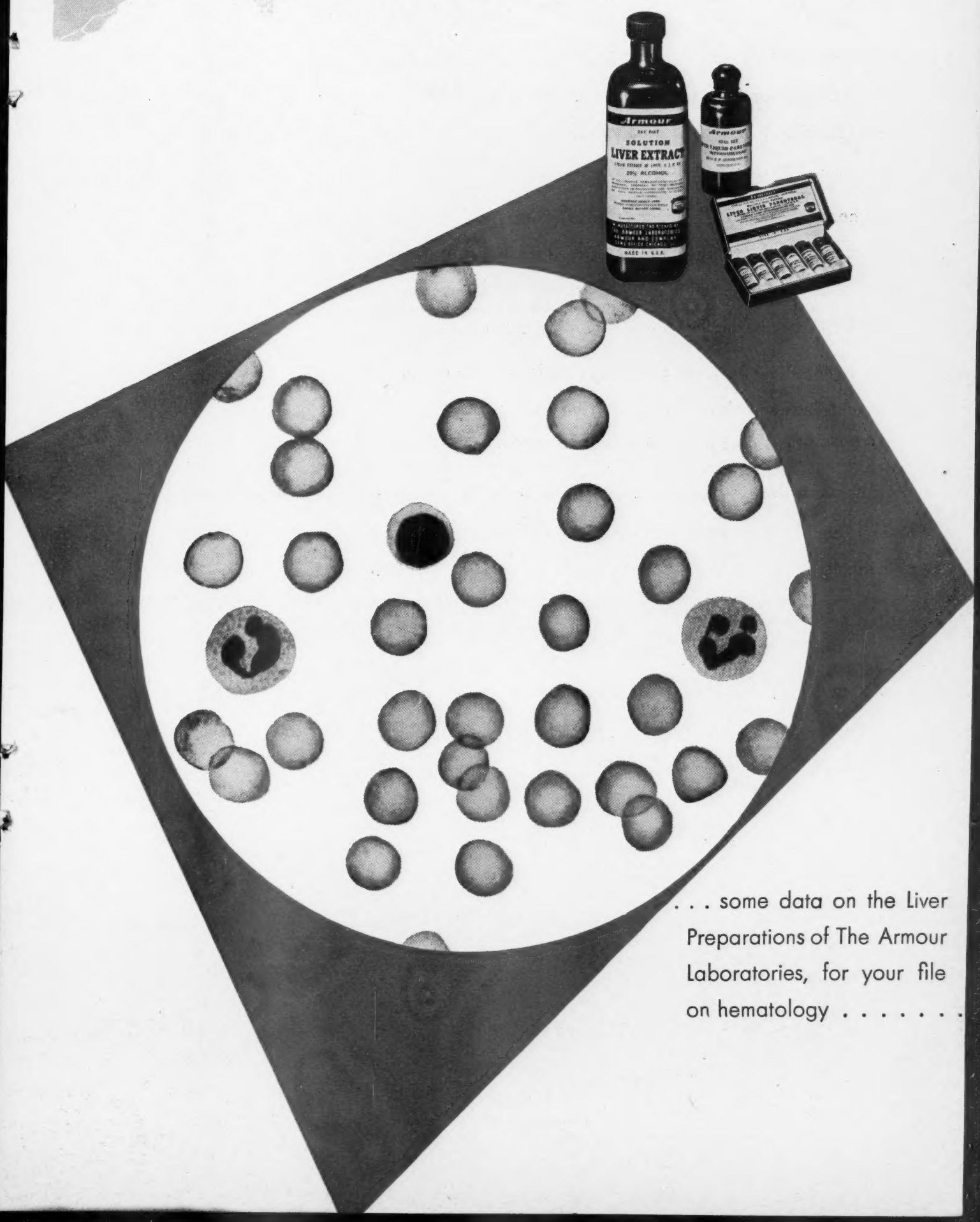

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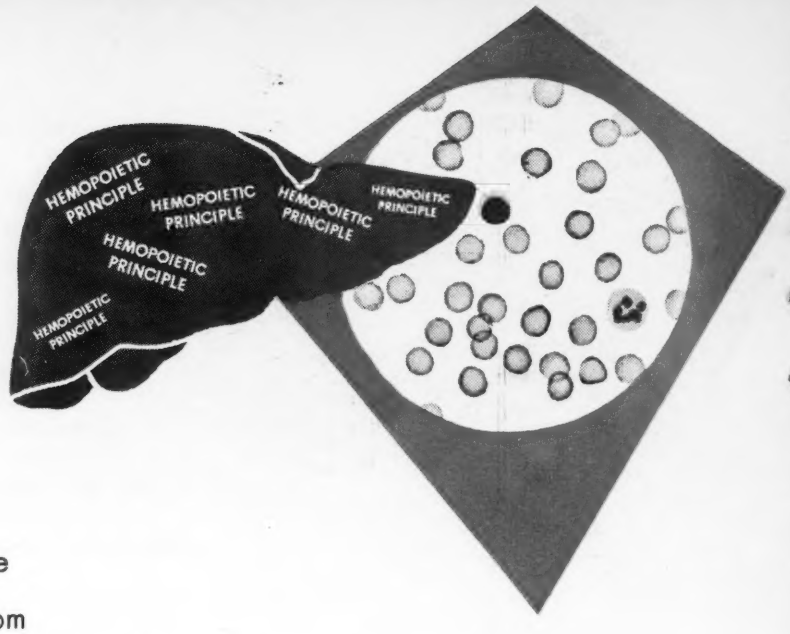
the liver is the storehouse for the hemopoietic principle . . .

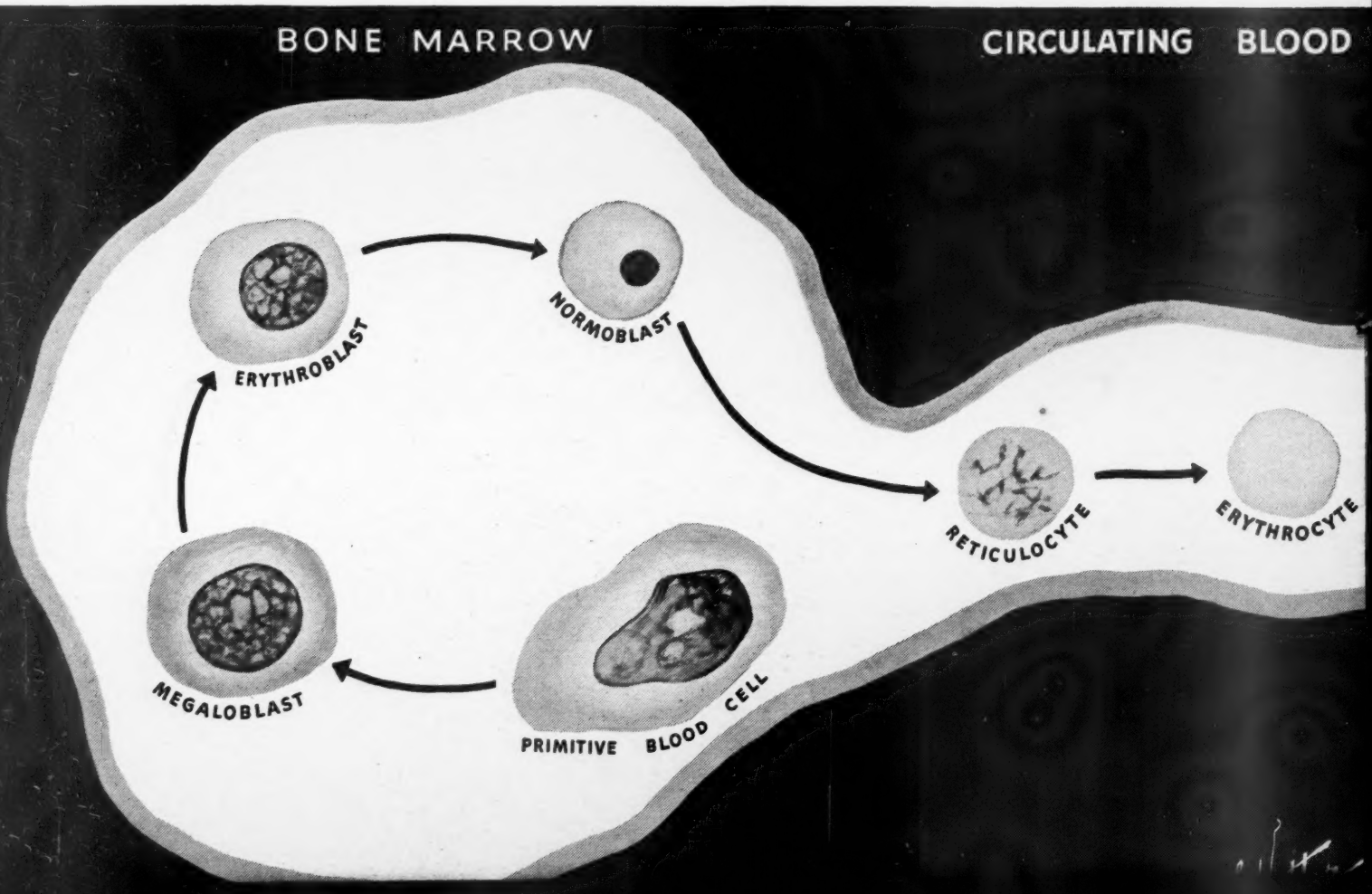
This blood making principle is essential to proper development of all red blood corpuscles. When the hemopoietic principle is deficient, the formation of red blood cells becomes disordered.



The hemopoietic principle is produced by the interaction of the extrinsic factor derived from normal, proper diet, and the intrinsic factor (probably of enzyme nature) found in normal gastric juice.

The hemopoietic principle thus produced is absorbed from the intestines and stored in the liver until it is used by the bone marrow for the growth and maturation of the red blood cells.

in pernicious anemia, erythropoiesis is abnormal and insufficient . . . and normal erythropoiesis must be restored, through the provision of adequate amounts of the hemopoietic principle . . . via liver therapy.



the reticulocyte response is a measure of the effectiveness of pernicious anemia therapy . . . .

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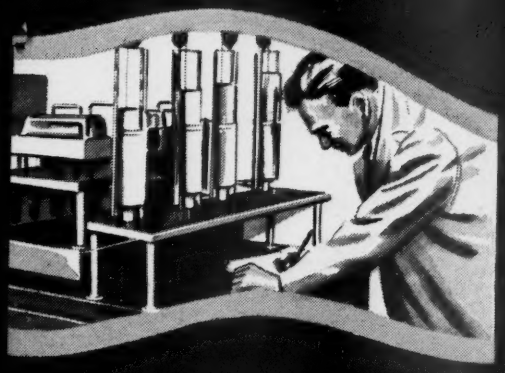

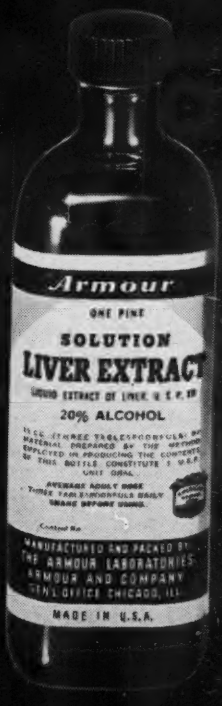

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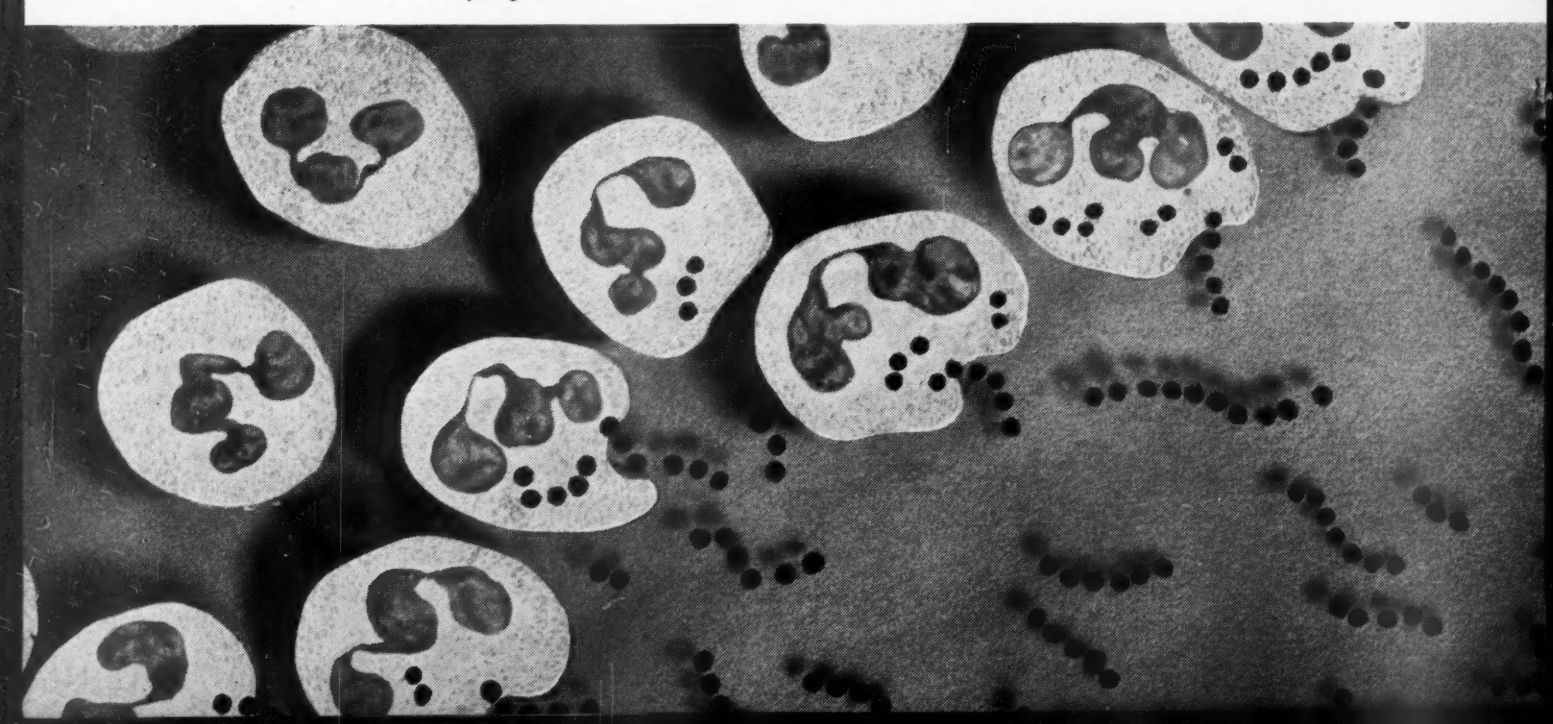

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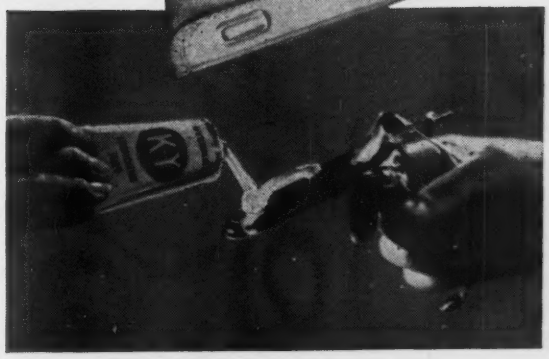

SPREADS READILY—ADHERES

Active ingredients: chondrus, tragacanth, glycerine, water, boric acid.

K-Y LUBRICATING JELLY

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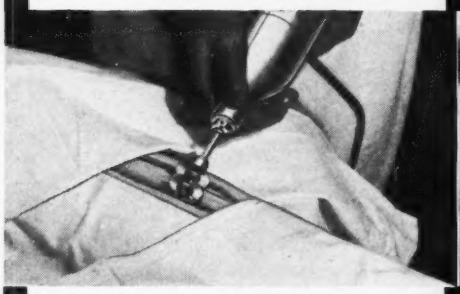
THE *Luck*

BONE SAW

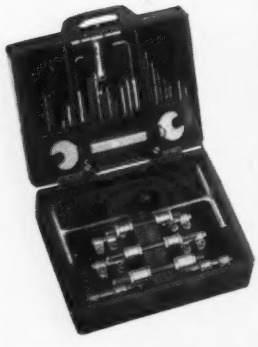
- **Speeds Orthopedic Bone Surgery.**
- **Motor Unit and Cord Can Be Sterilized In Autoclave.**

The Luck Bone Saw used with slotting burr in making transverse end cuts during removal of bone grafts, after longitudinal cuts have been made with circular saws.



The Luck Bone Saw used with twin circular saws. They rotate up to approximately 1500 revolutions per minute. Have great power. Do not jam or burn the bone. Second blade can be readily removed if only single blade is desired.

The Luck Bone Saw used with burr in cutting a graft for fusion of metatarso-cunieform joint. The cutting burr has a multitude of uses in instances where circular saws are either too large, too dangerous, or inaccessible to the operative field.



The Luck Bone Saw in fitted case with complete equipment.

● OVERWORKED orthopedic surgeons and shorthanded operating teams find the Luck Bone Saw a time and labor saving surgical aid. It operates on 110 A. C. or D. C. current. The motor unit provides a high speed of 13,000 R. P. M. at the small end, and gearing reduces speed, 6 to 1, at the other end, to which Jacobs Chuck is attached. This high speed makes possible the use of very small diameter slotting burrs. Low speed provides an ideal means for inserting Steinman Pins.

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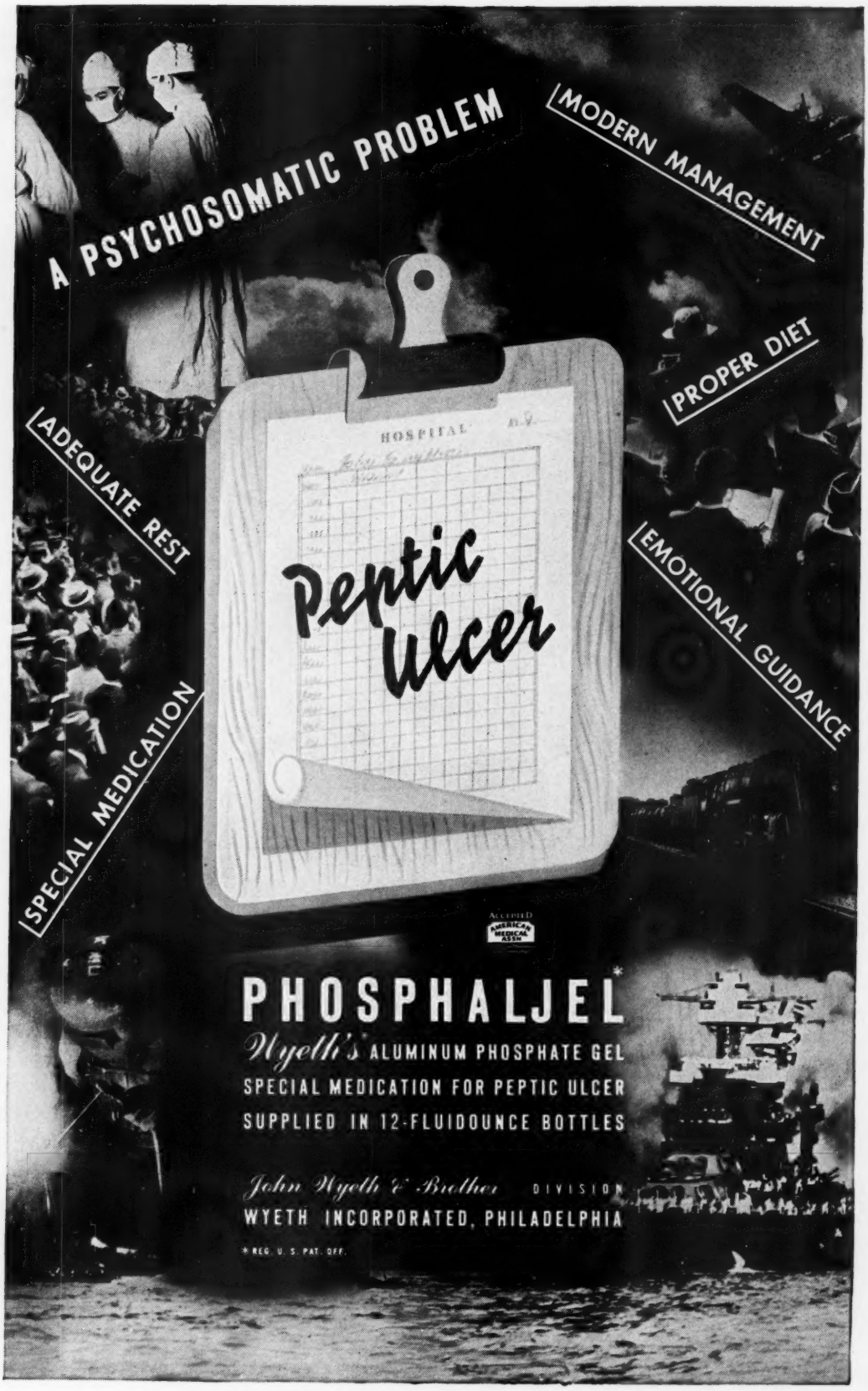
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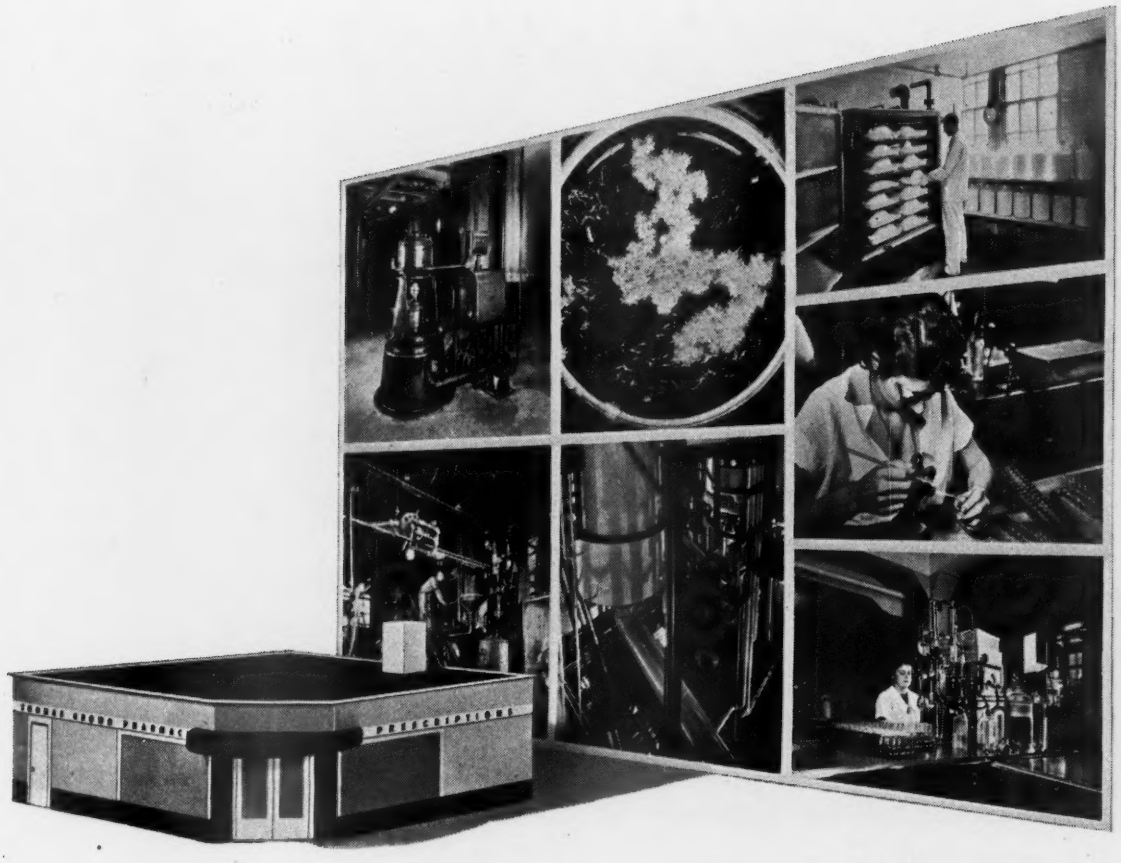

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Eli Lilly and Company has been prominent in the study of the barbiturates and is responsible for 'Amytal' (Iso-amyl Ethyl Barbituric Acid, Lilly), 'Sodium Amytal' (Sodium Iso-amyl Ethyl Barbiturate, Lilly), and 'Seconal Sodium' (Sodium Propyl-methyl-carbinyl Allyl Barbiturate, Lilly), each a leader in its field.

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Each capsule of Noviplex contains:

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Riboflavin	1.0 mg.
Niacinamide	8.0 mg.
Pyridoxine hydrochloride	0.1 mg.
Calcium pantothenate	0.2 mg.

plus all other factors naturally occurring in yeast concentrate. Noviplex is supplied in bottles of 100 and 500 capsules.

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Aggressive little atom of American bird-life, the beautiful Humming-bird flies so fast that the eye can scarcely follow. It operates its wings with such incredible power and speed that it is enabled to stand still—literally poised in air—as it gleans the nectar of flowers.

Similarly, the ability to remain "poised" over painful areas is attributed to small quantities of EUCUPIN, the local anesthetic-analgesic agent. Like the Humming-bird, Eucupin possesses a remarkable kind of *staying power*—the kind that controls pain for longer periods than any other agent, the effect lasting for hours and even for days.

Eucupin has been especially formulated for particular indications. They are described in a literature booklet, which, together with samples, is available to physicians on request. Please indicate form desired.

Supply: Aqueous and oil solutions for infiltration; ointment and suppositories; tablets for solutions to be applied topically.

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Brand of Isoamylhydrocupreine
Non habit-forming . . . Reduces need for narcotics

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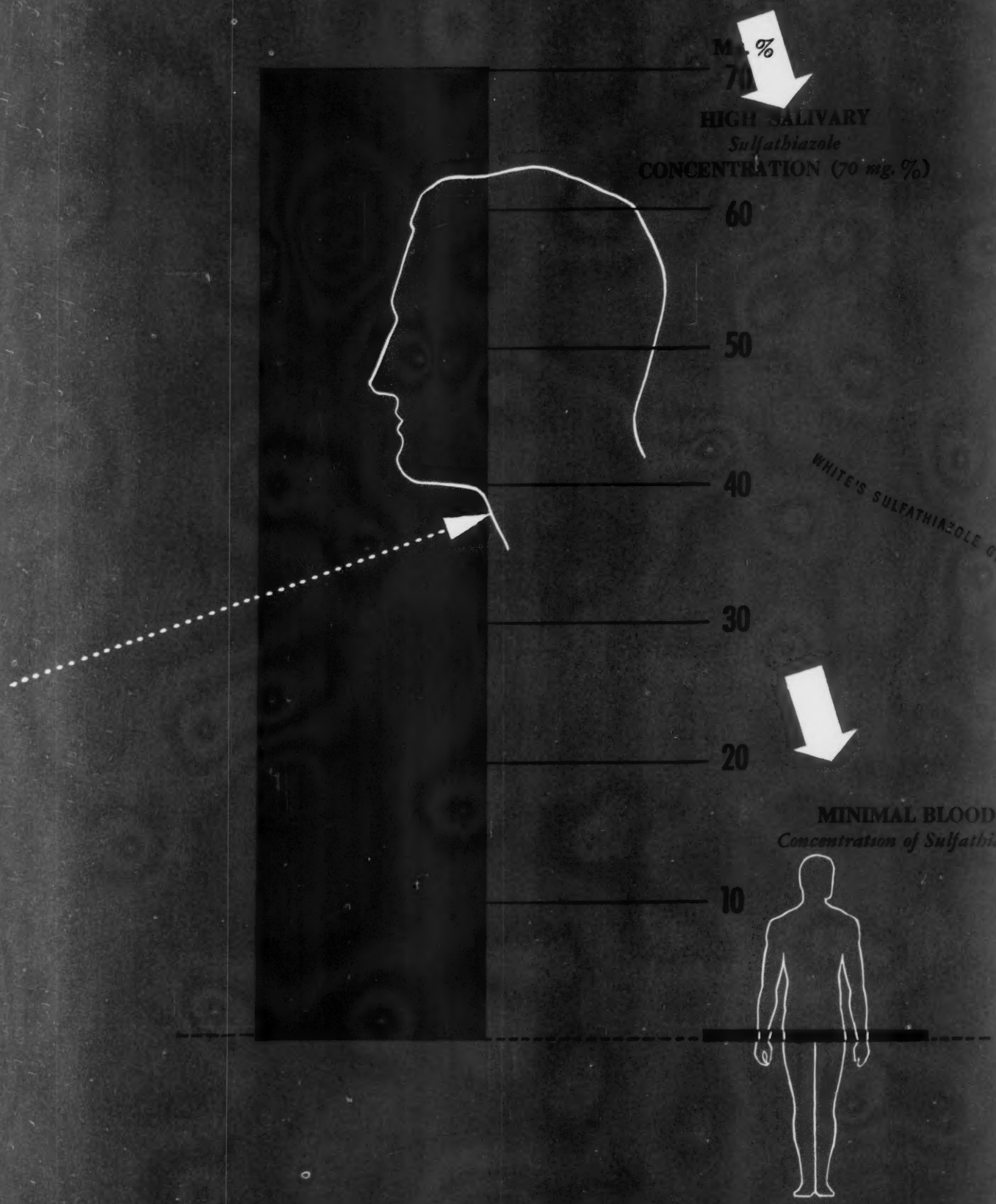
"Eucupin" Reg. U. S. Pat. Off.

The local anesthetic-analgesic with "STAYING POWER"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HIGH SALIVARY
Sulfathiazole
CONCENTRATION (70 mg. %)
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WHITE'S SULFATHIAZOLE GUM
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MINIMAL BLOOD
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Throat Chemotherapy without Systemic Toxicity

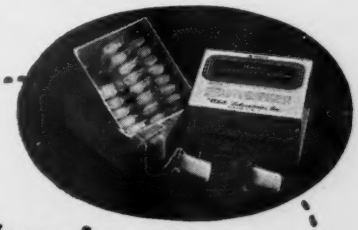
White's Sulfathiazole Gum provides a high and very *prolonged* salivary concentration of *locally active* sulfathiazole throughout the whole oropharyngeal area—with almost negligible elevation of the blood level.

One tablet, chewed for one-half to one hour, promptly initiates a high salivary concentration of dissolved sulfathiazole—and *maintains* throughout a full hour's chewing period, an average concentration of 70 mg. per cent.

Yet even with *maximal* dosage, and even in children, resultant blood levels are not even quantitatively measurable for the most part and at no time exceed 1 mg. per cent. Freedom from the likelihood of systemic toxicity is obvious.

Valuable in the treatment of such conditions as septic sore throat, peritonsillitis, pharyngitis, tonsillitis, infectious gingivitis. Widely prescribed—ethically promoted, of course.

White's Sulfathiazole Gum is supplied in packages of 24 sanitaped tablets, in slip-sleeve prescription boxes—on prescription only. White Laboratories, Inc., Pharmaceutical Manufacturers, Newark 7, N. J.



WHITE'S SULFATHIAZOLE GUM WHITE'S SULFATHIAZOLE GUM

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Relaxant ...par excellence

More than 50,000 injections of Intocostrin have been given. A very clear appraisal has been made of the remarkably uniform response obtained on its administration to human beings. . . . Supplied in 5-cc. rubber-capped vials, containing the equivalent of 100 mg. of standard curare; more than sufficient for one injection.

After extensive laboratory studies and several years of clinical investigation the Squibb Laboratories offer Intocostrin—a uniform, physiologically standardized preparation of curare.

Useful in Several Clinical Fields

In Shock Therapy of Mental Disease: Intocostrin, administered intravenously, prior to convulsive shock therapy almost completely eliminates the hazards by "softening" the convulsions.

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As a Diagnostic Agent in Myasthenia Gravis: Intocostrin in small doses accentuates symptoms in myasthenic patients—a most certain diagnostic procedure for this disease.

*"Intocostrin" (Reg. U. S. Pat. Off.) is a trade-mark of E. R. Squibb & Sons.

For further information and literature, write to the Professional Service Dept., E. R. Squibb & Sons, New York 22, N. Y.

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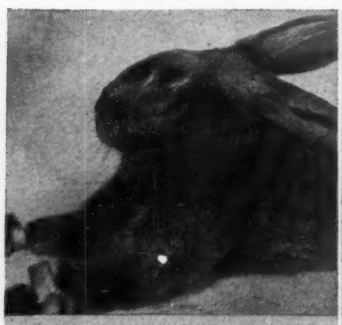
Manufacturing Chemists to the Medical Profession Since 1858



Normal rabbit before injection.

End point of test, with head resting on board. Rabbit is unable to raise head when stimulated.

Curare produces temporary relaxation of all voluntary muscles. Animal recovers fully in 15 to 20 minutes.

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WHETHER you buy medical equipment for private practice or for a hospital, always it is with the hope that time and experience will prove that you correctly judged its value.

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If you haven't had experience with G-E x-ray or electromedical equipment, you'll not take for granted that it is of the fine quality you are looking for. But to countless thousands of other physicians, hospitals, and clinics, the world over, equipment bearing the GE *trademark* is accepted without question, because they have learned from experience that in all G-E equipment this desired fine quality is inherent.

This reputation for inherent fine quality has been earned the hard way—by strict adherance to definitely established policies and ideals throughout a half-century of service to the profession. And it perhaps best explains why a G-E apparatus, wherever it may be used—in physicians' offices, or in civilian or military hospitals, in any and all climes—always can be relied upon to give the eminently satisfactory service that characterizes all G-E products.

Though your plans for buying an x-ray or electromedical apparatus may be yet rather indefinite, may we suggest that in the meantime you obtain further information through our local representative, whose branch office address we will be glad to send you. Address Dept. E25.

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THIS GROUP OF COMPOUNDS IS EFFECTIVE AGAINST:

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MERCK & CO., Inc. *Manufacturing Chemists* RAHWAY, N. J.

The local and constitutional bacteriostatic treatment of burns with . . .

Sulfadiazine
Lederle

BACTERIOSTASIS is essential for healing in extensively burned areas. This may be achieved by appropriate surgical and medical measures adopted immediately after the injury is received. The most important bacteriostatic measure is the use of sulfonamides.

SULFADIAZINE *Lederle* may be employed locally in the form of "SULFADIAZINE IN ETHANOLAMINES SOLUTION (PICKRELL) *Lederle*," or "SULFADIAZINE OINTMENT *Lederle*."

SULFADIAZINE *Lederle* may be given by mouth if drug blood levels remain insufficient to inhibit bacterial growth. Caution should be observed in the simultaneous use of oral and local therapy since excessive drug blood levels may result. Maintenance of urinary output between 1,000 and 1,500 cc. daily and an alkaline urine are advisable during intensive Sulfadiazine therapy.

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1 ounce tube, ¼ and 1 pound jars

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(Sulfadiazine, 5%—Tannic Acid, 10%)
1 ounce tube, ¼ and 1 pound jars

SULFADIAZINE SURGICAL POWDER STERILE
5 Gm. in vial

SULFADIAZINE OPHTHALMIC OINTMENT
(*Sulfadiazine* 5%)
⅛ ounce tube

SULFADIAZINE IN ETHANOLAMINES SOLUTION
(*Pickrell*)
8 fluid ounces and 1 pint (16 fluid ounces)

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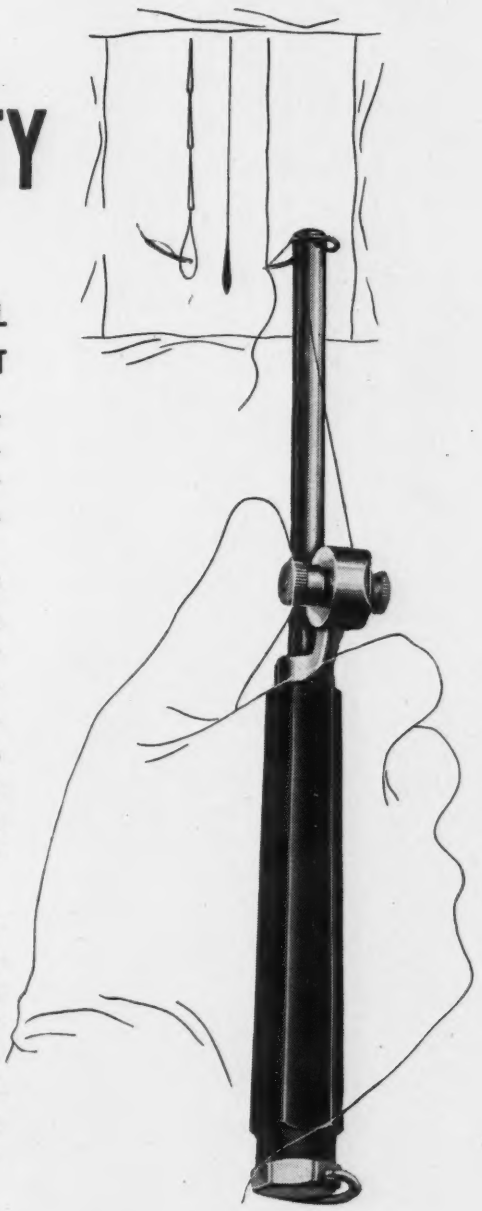
WITH THE

SINGER SURGICAL STITCHING INSTRUMENT



Since surgical cases vary so widely in their operative requirements . . indeed, any standard operative procedure itself may undergo necessary variations for individual patients . . . the surgeon's resourcefulness and judgment are ever at a premium.

This is as true in suturing as in any other phase of the surgical procedure. It emphasizes the value of the Singer Surgical Stitching Instrument, which not only brings to the surgeon's hand a greater speed and accuracy in executing old familiar stitches, but makes available a whole series of new continuous stitches—secure, yet easily unravelled — each with special virtues. It permits an accurate response to every detail governing a discriminating choice of stitch, as suturing conditions may require.

This precision-made surgical instrument—so versatile in making a variety of stitches old and new to surgical technique—can employ any standard suturing material, or be fitted from a wide variety of available needle sizes, shapes or styles — for use in either a deep or superficial field. It is sterilizable as a complete unit; and may be readily taken apart for cleaning and quickly reassembled. All parts are rust-resistant.

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Personal demonstration available at your local Singer Shop

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However surgical blades may be judged, Crescent Blades measure up on every count! They possess an *unusually keen cutting edge*... they exceed the requirements of official "*rigidity*" and "*deflection*" tests... they are *nicely balanced*, without thinning down from the back . . . they show a superior *adherence to specifications*, both in *structure* and *performance* . . . and they fit your budget!

No wonder they're the preference of so many discriminating surgeons all over the country! Price: $1.20 per doz., $12.96 per gross. Check now on these "Master Blades"!

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SURGICAL BLADES AND HANDLES

FROM THE PORTRAIT BY JOHN SINGER SARGENT

COURTESY SCHOOL OF MEDICINE, UNIVERSITY OF PENNSYLVANIA

J. William White, M.D.

1850-1916

Famous surgeon, teacher and writer. Professor of Clinical Surgery—later, John Rhea Barton Professor of Surgery (1887-1911), School of Medicine, University of Pennsylvania. One of the editors, "Annals of Surgery" (1892-1916). Author, "Genito-Urinary Surgery and Venereal Diseases" (1897).

No. 3 in the series, Great American Surgeons. Reproductions suitable for framing sent free on request to:

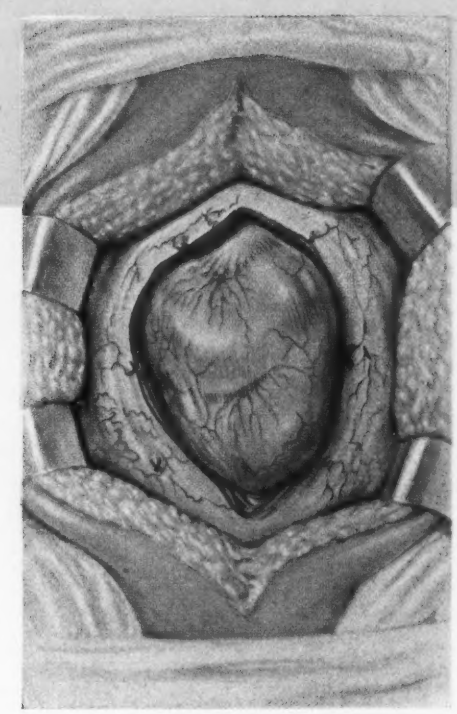
ETHICON SUTURE LABORATORIES, DIVISION OF JOHNSON & JOHNSON, NEW BRUNSWICK, N. J.

Herniotomy for Ventral Hernia

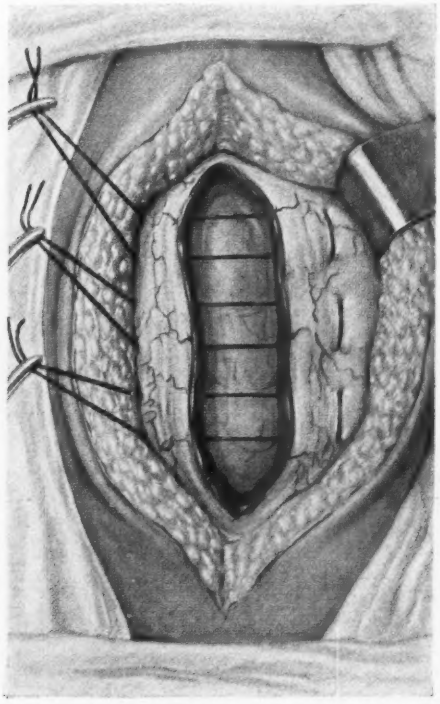
Utilizing Fine Gauge Chromic Catgut and Modification of Edebohl's Technic

This operation demonstrates the manner by which fine gauge chromic catgut may be used to approximate fascia under tension. The placing of heavy gauge temporary tension sutures and secondary incisions make possible thorough and firm approximation by fine gauge chromic sutures.

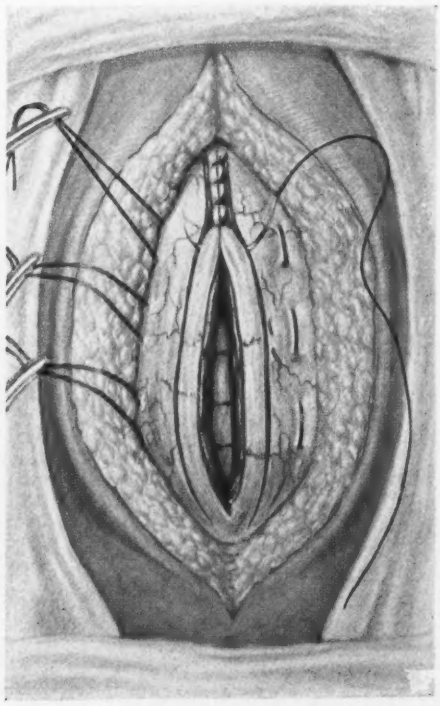
The established principle of the desirability of minimizing tissue reaction is here applied in the use of fine gauge chromic catgut where heavy gauge or non-absorbable suture materials were formerly utilized.



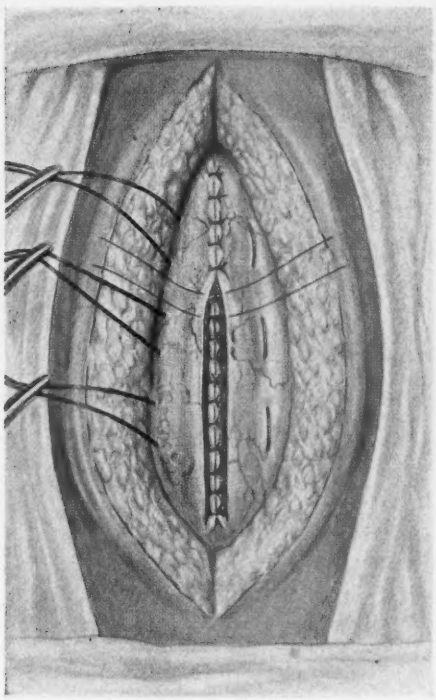
1. The incision has been carried through to the peritoneum. Bleeders have been ligated with Size 000 Medium Chromic Catgut. Note extent of fascial defect.



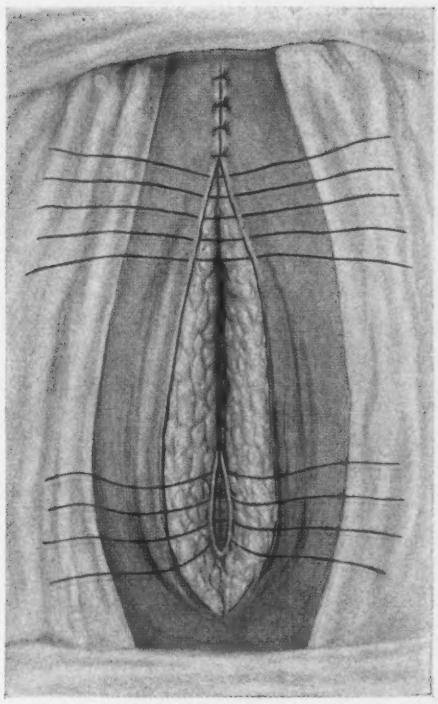
2. Wide area of lateral fascia has been exposed. Three mattress sutures of Size 3 Chromic Catgut or heavy silk have been placed to provide temporary tension.



3. Two longitudinal fascial incisions have been made. The fascia is drawn together by tension applied to temporary sutures and a row of interrupted Size 00 Chromic Catgut Sutures placed. Note use of swedged needle to reduce trauma.



4. Initial row of fascial sutures has been completed. Second layer of fascia is now approximated by interrupted Size 00 Chromic Catgut Sutures.



5. Herniotomy completed with two layers of fascia approximated by interrupted fine gauge chromic sutures. Temporary tension sutures have been removed. Skin closure by interrupted black silk.

For Reduced Trauma..Less Tissue Reaction..Faster Healing
Use Ethicon Tru-Chromicized Fine Gauge Sutures

The advantages of fine gauge suturing, reduced trauma, lessened tissue reaction, faster healing, may be achieved with safety by using Ethicon Tru-chromicized, fine gauge catgut sutures.

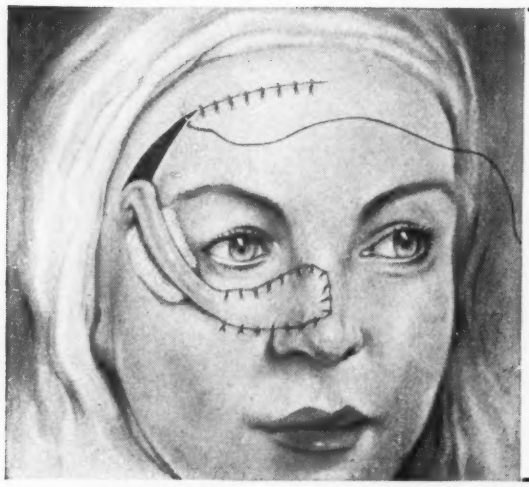
- Ethicon fine-gauge sutures possess a greater strength-diameter ratio than larger sizes.
- Gauge uniformity, six times greater than U. S. P. requirements.
- Tru-chromicized fine gauge sutures retain their integrity longer than chromicized sutures of larger gauges.
- Exceeding U. S. P. tensile strength requirements (averaging 20% or more on knot pull), Ethicion fine gauge sutures provide a substantial margin of safety against breakage.

To complement your skill as a surgeon, specify Ethicon.

ETHICON
LOCK KNOT
SUTURES

ETHICON SUTURE LABORATORIES

4 new types of
ETHICON SUTURES
for special surgery



Plastic Sutures

Ethicon Plastic Sutures are supplied in Twisted Silk, Surgical Nylon and Drawn Silkworm Gut. They are equipped with specially designed eyeless Atraloc Needles, particularly adapted to plastic or cosmetic surgery.

← Tubed pedicle flap from forehead for repair of middle section of nose and adjacent area (diagrammatic).

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Special care has been taken to make Ethicon Eye Sutures extremely pliable, to meet the surgeon's need for a suture that passes easily through tissue and ties readily in small areas. Supplied in surgical gut and silk, equipped with eyeless Atraloc Needles.

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Ethicon Gastro-Intestinal Sutures are supplied in surgical gut, silk, cotton and linen, all with eyeless Atraloc Needles. Several sizes and shapes of needles are available, to meet the varying needs of the surgeon. These sutures are supplied in standard sizes.

Nylon Sutures

Ethicon Surgical Nylon is supplied in standard sizes, sterile in tubes and non-sterile in coils. The tubed sterile nylon is specially processed for improved flexibility and elasticity. It is ready to use, requiring no soaking or conditioning.

Ethicon Surgical Gut Advantages

TRU-GAUGING . . . 6 times greater gauge uniformity than U.S.P. requirements.

GREATER UNIFORMITY OF TENSILE STRENGTH.

TRU-CHROMICIZING . . . uniform distribution of chrome from center to periphery.

LOCK-KNOT FINISH.

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Division of Johnson & Johnson *New Brunswick, N.J.*

World's Largest Manufacturer of Surgical Catgut

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Fifty-third Year of Continuous Publication

NEW SERIES VOL. LXIV MAY, 1944 NUMBER TWO

Editorial

MEDICAL CONTROL

WHILE a majority of the members of the medical profession in this country are concerned and apprehensive of the proposed Wagner-Murray-Dingell bill and all it implies, Dr. Betram M. Bernheim, associate professor of surgery at the Johns Hopkins University Medical School and author of "Medicine at the Crossroads," presented on February 25th, before the Physicians Forum, at the Kips Bay Health Center, a program for what he termed "tomorrow's medicine," and outlined eight vital objectives aiming to place medical practice on a *sound foundation*. These objectives would provide equitable distribution of physicians, guarantee the physician's economic security and provide adequate medical care to the masses of the people.

Dr. Bernheim said that the majority of the medical profession fear a medical "dictator" and in order to eliminate this fear he suggests a five-man mixed Federal medical commission, three doctors and two laymen, who will have charge of administrating medical practice throughout the country. This commission would be appointed by the President, with Senate approval, and the term of office of each member of the commission would be staggered. The term of tenure in office would be six years on a full-time salaried basis. The group would "administer, supervise and coordinate all civilian medicine."

In the New York Times we read the following:

"The first immediate objective of the commission would be the provision of medical care to the returning servicemen. Seven other major objectives would be (1) determination of the number of doctors the nation needs; (2) distribution of doctors according to the needs of the population; (3) assuring the financial security of the medical personnel; (4) provision of medical care and attention to the masses of our people; (5) preventive medicine; (6) autonomy of medical schools and medical institutions generally; and (7) hospitalization."

Dr. Bernheim said that the main contributing cause of present-day, unequal distribution of medical care is the lack of a fixed plan for distribution of physicians. We quote from Dr. Bernheim's address:

"To bring order out of chaos," he said "the medical profession must devise a plan for distributing its personnel. Before this can be done the doctor needs of the nation must be determined, while at the same time some scheme for giving financial support to medical students and doctors going into practice must be devised. . . . When 20,000 or 30,000 young doctors of the armed forces, who never have had civilian prac-

tice, return to civilian life a problem unique and loaded with dynamite will confront the medical profession and the nation.

"In danger of being socialized and not realizing it, the medical profession had best cooperate with the Government, collaborate and be more reasonable. With the masses demanding medical care at a price they can afford if organized medicine can find a better or surer way than compulsory health insurance to secure the required money, well and good, but failing that it must agree to it and quit stalling.

"Being financed by the Government from the day they start studying medicine until they are able to support themselves by taking positions with industrial concerns or medical institutions, joining a group or practicing alone, doctors will at long last be freed from that old dreaded wasteful period of waiting for patients, and society will get the services it needs. Licensure will become obsolete, his medical degree entitling a man to practice anywhere in the United States.

"A wise profession will control its own destinies by collaborating and cooperating with the Federal Medical Commission; it will decide who will study medicine, have control of medical schools, hospitals and laboratories, but it must guarantee that its personnel will be out there where they belong—even if at times and for certain purposes United States Public Health Service doctors must be called in."

This is a fragmentary outline of this, another, proposed plan. Maybe it has merit; maybe it is another impractical visionary scheme full of flaws. We are in no position to offer an opinion. But several thoughts keep going through our brain: Why cannot the States look after and control their special medical problems? Should the "backward" States be unable financially to put in effect a worth while, full-scale, medical-care program could not a legal means be found to seek and receive federal aid? In communities lacking medical personnel cannot the State advertise and offer attractive rewards for physicians to settle in these communities and practice? The cost involved would be widely different in different locations; a community in Mississippi would not call for the same overhead as a community in rural New York or Illinois. Could not the Public Health take over these far-away, poor, neglected places and provide physicians? It might look attractive to many of the present day, three-year graduates with a nine months' internship when the war is over and they are returned to civilian life.

The world is in a turmoil; positive opinions of today go out of the window tomorrow. After all would it not be good sense to let things remain in status quo until the war is over, until the "boys" have come back, and the master minds are fiddling with the future peace of the world?

T. S. W.

Original Articles

RESUSCITATION OF THE HEART*

ROBERT F. BARBER, M.D.
Professor of Clinical Surgery,
Long Island College of Medicine
BROOKLYN, NEW YORK

AND

CAPTAIN JOHN L. MADDEN
MEDICAL CORPS,
ARMY OF THE UNITED STATES

IN the everyday practice of surgery many problems confront the surgeon. Some are obviously difficult and challenge his ingenuity. Others are obscure in nature, equally difficult and offer a still greater challenge. Cases of acute cessation of the heart beat come under the latter category.

In the past twenty-five years the advances in surgery and associated sciences have been rapid and progressive. Because of this the well trained surgeon of today is fortified with a wide and varied knowledge which enables him to offer his patients untold advantages.

The risk of operation has been markedly lowered by the strict attention to details with respect to the preoperative care and study of the patient. The surgeon institutes any corrective measures that may be necessary and thus places the patient in the best possible condition for operation. As a result, the operative risk entailed is lowered to a minimum and in the words of the late Dr. Daniel F. Jones, "The patient is made safe for surgery and surgery safe for the patient."

Despite all these added precautions there are patients in whom sudden and complete cessation of circulation and respiration occurs either during the induction stage of anesthesia or at any time during the course of an operation. It is with this particular group of cases that this study is concerned.

There is nothing so disheartening to a surgeon as "to lose a patient" on the operating table during an uncomplicated and technically simple operation. The appalling fact is that so many of these catastrophes occur among patients of previous sound health.

We know of no surgical emergency which outranks cardiac arrest and yet its treatment is grossly inadequate. Why the latter should exist in the light of present knowledge is difficult to understand. Bailey, Primrose, Norbury and Nicholson in England, and Bost and Beck in this country have been for many years strong proponents of immediate surgical attack in cases of acute stoppage of the heart. Despite repeated advice referable to having a preconceived plan of therapy if this emergency should arise, persistence in the use of ineffectual, conservative measures still obtains. This results in unnecessary delay. Thus, if surgery is done at all it is performed as a last resort and at a time when it has the least chance of success.

Boldness in execution and speed of action are mandatory. The early performance of cardiac massage is a *sine qua non* of success and should be our initial thought and not used as a last resort. This point cannot be stressed too strongly since the mortality will vary in direct proportion to the time interval between acute cardiac arrest and the beginning of proper treatment.

The purpose of this paper is to emphasize again those facts which will lead one to

* From the Department of Surgery, Long Island College of Medicine Division, Kings County Hospital, Brooklyn, New York.

treat patients with acute cardiac standstill in a properly prescribed manner.

INDICATIONS FOR MASSAGE OF THE HEART

The evident reason why delay in performing cardiac massage is so prevalent is a lack of knowledge of the underlying indications for its performance. The prime indication for cardiac massage is acute cardiac arrest.

The question often arises, when has the heart stopped beating? A lack of the proper answer produces delay in treatment. For purposes of clarity we may classify cases of acute cardiac standstill into three groups: (1) simultaneous failure of respiration and circulation; (2) respiratory failure with subsequent arrest of heartbeat; (3) acute cardiac standstill with resulting secondary failure of the respirations.

In Group I, if an evident response to the usual methods of resuscitation does not occur within one minute manual massage of the heart should be performed and an adequate artificial respiration maintained. The peculiar appearance of the patient in which there is a complete cessation of the heart beat and respiration is pathognomonic. The staring expression, the relaxed jaws, the fixed pupils, the grayish pallor and mottling of the skin are all characteristic. It was this same picture, described by the earlier writers as "white asphyxia." When once seen its future recognition is not difficult. If present, there should be no delay in performing cardiac massage.

To determine definitely that the cessation of the heart beat is complete Primrose (1935) advocated the use of amyl nitrate. He stated that the ordinary "faint" recovers immediately with an artificial inhalation of the drug, whereas the arrested heart cannot respond.

In cases of the second group, cardiac standstill occurs during a variable period following the arrest of the respirations. In the frantic efforts to reestablish respirations the arrest of the heart is unrecognized. Following the establishment of a patent air way and adequate respiratory exchange, the expected response does not occur. It is then that attention is focused upon the heart. Further delay in the performance of massage results from the administration of varied cardiac stimulants, the most popular being the intracardiac injection of epinephrine. It is in cases of this group that the anesthetist or surgeon, as the case may be, should appoint a competent assistant to the task of observing the competency of the circulation. When there appears clinical evidence of cessation of the heart beat this information should be immediately rendered, and preparations made for performing manual cardiac massage if the expected improvement does not ensue within a short period. This meets with the objection by many who state that the circulation is still adequately maintained despite the absence of the heart beat and a recordable blood pressure. The burden of proof rests heavily upon those who for this reason object to massage. It is here that massage of the heart, if performed at all, is performed too late.

In Group III we find the smallest number of cases. It is rare to have complete cessation of circulation and persistence of normal respirations since the latter fails either first or simultaneously with the circulation. However, if such does occur, the respirations cannot conceivably persist for more than a few seconds. This group should be benefitted byearly massage since attention is directed primarily to the impairment of the circulation. It is the first sign of difficulty perceived by the anesthetist. The premonitory signs may be in the form of an increase in pulse rate or a cardiac arrhythmia. However, delay in massage occurs when time is consumed in the administration of cardiac stimulants. These drugs, in our experience do nothing more than sensitize an excitable heart with the resulting production of ventricular fibrillation and death.

Here again the importance of team work and prompt action is paramount. If cardiac massage is performed before irreparable

changes have occurred and if artificial respiration is maintained, a successful and complete recovery should occur.

ARTIFICIAL RESPIRATION

The establishment and the maintenance of a patent airway in conjunction with artificial respiration is the *sine qua none* of success in cardiac resuscitation. Massage of the heart alone is of no avail if proper exchange of the gases in the pulmonary alveoli cannot occur. The converse is also true, although it has been stated[102] that "proper pulmonary ventilation may prolong the period of possible resuscitation beyond the 5–8 minute limit and allow more time for the restoration of the cardiac activity." This statement receives no support in scientific fact. It is impossible to transport oxygen to the brain if the heart is at a standstill. Artificial respiration in the absence of the circulation is worthless.

The value of a mechanically controlled, automatized type of breathing in intrathoracic operations and in resuscitation has been well demonstrated by both Crafoord[25] and Mautz.[78] By this method rhythmic insufflation during the inspiratory phase and a free outflow during expiration is obtained. It produces a type of breathing which more closely simulates normal respiration than any other method, but still it has not received the general recognition which it deserves.

If a machine of this type is not available, rhythmic compression of the rebreathing bag of the anesthetic machine will prove efficacious. The older methods of Sylvester and Schaeffer are inferior to those described, but in their absence, one or the other, preferably the Schaeffer method, should be used.

In cases of resuscitation, a spontaneous cardiac rhythm is obtained prior to the establishment of normal respirations. The latter function may be delayed for ten to thirty minutes following the return of cardiac function. It is, therefore, important to continue artificial respirations as long as the heart maintains its beat. Bohn[11] reported a case in which normal respiratory function was not obtained until two and one-half hours following the return of a spontaneous cardiac rhythm.

The delay in the return of respiratory function varies in direct proportion to the duration of cardiac arrest. If the latter persists until irreversible changes have been produced in the brain, normal spontaneous respirations will not be resumed. However, a pathologic respiratory variant may be produced and persist for a variable period dependent upon the degree of cerebral damage produced by the anoxia.

The respiratory apparatus is in reality a complex mechanism. Lumsden,[71,72] as a result of his experiments in cats, described three brain centers concerned with respiration: (1) pneumotaxic center, (2) apneustic center and (3) gasping center. The pneumotaxic center, located in the pons inhibits the activity of the apneustic center and produces normal breathing. The apneustic center when uncontrolled sends out impulses productive of prolonged inspirations. The gasping center is located in the lower part of the bulb, and, as its name implies, produces a gasping type of breathing.

In the respiratory tracings of animals dying from asphyxia, each of the above types of respiration may be demonstrated. The failure of the various centers occurs from above downward. The pneumotaxic center fails first, then the apneustic and finally the gasping center. Breathing which at first is regular becomes slow. This is followed by prolonged inspirations associated with gasping and finally gasping alone which maintains life for a short time. Recovery is in the reverse direction, i.e., gasping, prolonged inspiration, slow regular respirations and finally normal breathing.

This work of Lumsden has not been fully accepted by physiologists and further confirmation is necessary. However, it is of clinical interest to note that in one of the cases reported below (Case 11), recovery of respiratory function proceeded as Lumsden described. In this case recovery was

incomplete in that the pneumotaxic center failed to recover.

It is most important to emphasize the interdependence of the circulatory and respiratory systems in the maintenance of life. Whichever system fails first is of no great concern. It is the early recognition of failure and the immediate institution of the appropriate corrective measures which is most important. Respiration and circulation are all too often thought of as individual entities instead of a vitally balanced unit, the appreciation of which is essential for successful resuscitation.

RESUSCITATION OF THE HEART

The period of resuscitation may be defined as the period following acute cardiac arrest during which time the normal rhythmical contractions of the heart may be restored and complete recovery ensue. Its duration has not been exactly determined. The earlier writings were indefinite on this particular point and as a result many and varied time intervals have been quoted, ranging from eight up to as long as fifteen minutes. However, it is the opinion of most present day writers that the period during which resuscitation may be completely successful is not in excess of five minutes and most probably between three and four. We are in complete agreement with this statement.

Carrel[20] differentiates between general and elemental death. The former is manifested by a complete stoppage of the circulation in whieh the organs are still living and could be completely revived if they were given back their normal physicochemical conditions by re-establishment of the circulation. When, however, protoplasmic degeneration and death of the tissues occur as a result of a prolonged interruption of the circulation, it is spoken of as elemental death. Immediately following the cessation of the heart beat the organism is placed in a position intermediary between general and elemental death. Nevertheless, as long as elemental death of the tissues has not occurred, complete resuscitation is possible. It then follows that the length of time during which the heart beat may be inhibited with ultimate complete recovery is dependent upon the rate of development of elemental death.

The cells of the cerebral cortex are the most sensitive in the body and are the first to be affected by the interruption of the circulation with its resultant ischemia and anoxemia. The cells of the medulla oblongata, spinal cord and peripheral nerves, respectively, are next in order of frequency to be affected. The tissue cells of the heart, however, are more tolerant and can recover function following periods of cessation of the heart beat from twenty-four to thirty-six hours. Similarly, other tissues like the kidneys and liver may recover complete function following arrest of the circulation for fifteen to twenty minutes. Since a chain is as strong as its weakest link, it is important to know the length of time that the general circulation may be interrupted before permanent changes occur in the tissue cells of the cerebrum.

There have been many animal experiments performed to determine the exact length of time the central nervous system of the intact animal could withstand interruption of the blood flow without the production of permanent or irreversible changes. Sir Astley Cooper[23] (1836) in a series of animal (dog) experiments, performed bilateral ligation of the vertebral, subclavian and carotid arteries. He observed the resultant convulsions and rapid cessation of respiration. Subsequently similar experiments were performed by Magendie and Poiseuville[74] (1837), Pike and Stewart[89] and Hill and Mott.[57] Pike and Stewart concluded from their experiments that cerebral anemia of fifteen minutes' duration was incompatible with life. In their series of ninety-three experiments on cats only five survived following a period of cerebral anemia of seven minutes and only one after fifteen minutes.

From his clinical experience Trendelenburg[104] stated that any period over forty-five seconds was fatal and from his experi-

ments upon apes, he arrived at a similar conclusion.

A patient of Nyström's[86] made a complete recovery following occlusion of the aorta and pulmonary artery for one hundred and five seconds. O'Shaughnessy did not believe that permanent recovery could be guaranteed beyond a period of thirty seconds despite experiments to the contrary.

The experimental investigations of Ford[40] (1928) upon the effects of asphyxia on the brain of the cat demonstrated the fact that the animal could be resuscitated from three to five minutes after cessation of respiration. Beyond this period resuscitation was impossible.

Demarest and L'Hermitte[29] (1939) discussed at length the gross and microscopical findings in the brain resulting from asphyxia in a case in which death occurred two days following cardiac massage with incomplete recovery (five minute cessation).

Gildea and Cobb[44] (1930) pointed out the difficulties in the routine production of immediate and complete cessation of the circulation to the brain by the experimental methods in general use. This was due to the variations in the degree of collateral circulation to the brain following the ligation of all the principal vessels.

It remained, however, for Weinberger and Gibbon[109] (1940) to demonstrate by their ingenious method the exact period of ischemia and anoxia tolerated by the tissue cells of the brain. This method has completely overcome the uncontrollable factor of variations in collateral circulation previously mentioned. In an attempt to estimate the length of time that the central nervous system of an intact animal could withstand total interruption of the circulation without the production of permanent cell damage, these authors interrupted the circulation abruptly and completely by clamping the pulmonary artery. By observation of the retinal vessels they could determine the moment that the circulation returned to the cerebrum when the clamp on the pulmonary artery was released. From their experiments they concluded: (1) arrest of the circulation for three minutes and ten seconds or less was tolerated without any obvious neurological disturbances; (2) permanent alterations in psychic behavior occurred in those animals in which the circulation was arrested for three minutes and twenty seconds or longer; (3) when the circulation was interrupted for eight minutes and forty-five seconds or longer life could not be restored for more than a few hours.

These experimental findings are in agreement with clinical experience: Complete recovery results if the circulation is restored within five minutes following arrest of the circulation. The difficulty, therefore, is not so much in starting the heart but doing so before the vital tissues of the higher brain centers have suffered irreparable damage. It is, therefore, of the utmost importance to restore an adequate supply of oxygenated blood to the cerebral centers before irreversible changes (elemental death) have been produced.

Cases reported in the literature in which there has been cessation of the circulation for prolonged periods with ultimate complete recovery create a great deal of interest. In the case cited by Mollison[82] the period of cardiac standstill was reported to be not less than thirteen or more than twenty-four minutes. His patient remained unconscious for seven days and showed signs of severe cerebral irritation for a period of fourteen days. Permanent recovery ultimately occurred.

Fuizzy[42] reported a case of a seventy-year old man in which the heart beat was restored by the intracardiac injection of adrenalin thirty-five minutes after all heart action had ceased.

Hyman[61] reported two cases of cardiac standstill of eleven minutes and fourteen minutes, respectively, with recovery by the intracardiac injection of adrenalin in the first case and metrazol in the second. Kleinberg's patient recovered completely twenty minutes after cessation of the heart beat.

The only logical way to explain these successes after such prolonged intervals of time is on the basis that complete cessation of the heart beat had not occurred but was enfeebled to such a degree that it could not be detected by clinical methods. Just as long as a trickle of blood flows through the brain centers degeneration of tissue will not occur[89,99] and complete recovery is possible if the circulation be augmented by artificial means.

A point of the utmost importance is to define and understand what is meant by the period of cardiac arrest. If a basic understanding of this term does not exist the reporting of cases as successes beyond the generally accepted time limit in which successful resuscitation is possible, will of necessity occur. It may be defined as the time interval between the cessation of the heart beat and the performance of manual cardiac massage. It is not and should not be considered as the time interval between cessation of the heart beat and the restoration of a normal spontaneous cardiac rhythm. This is of paramount importance because the moment effectual manual massage is begun an artificial circulation is produced which adequately supplies the tissue needs of the body until a spontaneous heart beat and normal respirations are obtained.

In a recent paper reported by Adams and Hand,[1] the authors failed to take into consideration this particular point. In a review of the protocol it was noted that the heart was seen to stop beating during the course of an intrathoracic operation. Manual massage of the heart was begun immediately in conjunction with the maintenance of artificial respiration by strong rhythmic compression of the rebreathing bag with only oxygen flowing. Massage of the heart was continued for twenty minutes, subsequent to which spontaneous rhythmic contractions occurred. This was soon followed by the return of a spontaneous respiratory rhythm and an ultimate complete recovery. The authors concluded: "This case demonstrates that the time interval of cardiac arrest compatible with normal recovery is much longer than was formerly appreciated." We are opposed to this viewpoint. In fact we are of the opinion that the time interval of cardiac arrest compatible with normal recovery is less, if anything, than was formerly believed. In reality the period of cardiac arrest in the particular case quoted, did not exceed thirty seconds, since the heart beat was seen to weaken and then stop completely, following which massage of the heart was begun immediately. A competent artificial circulation was thus produced and at the same time proper oxygenation of the blood was obtained by the maintenance of artificial respiration. Therefore, normal conditions were simulated, which maintained the metabolic tissue needs of the vital centers until a spontaneous cardiac rhythm and respirations were resumed.

This case is of particular value in that it adequately demonstrates the importance of maintenance of both artificial circulation and respiration in the prevention of degenerative changes in the delicate nerve cells of the higher brain centers.

TREATMENT

Cardiocentesis. The use of this method is of historic interest but has no place in the present day therapy of cardiac arrest. The successes reported were attributed to the relief of the distended organ and to mechanical stimulation by the needle or trocar.

Cardiac Stimulants. Stimulation of the heart by the intracardiac injection of drugs, particularly epinephrine, is one of the most popular methods employed in cardiac resuscitation. However, despite the successes reported, it possesses certain disadvantages which may produce much harm if injudiciously used.

Epinephrine (adrenalin) is a valuable cardiac stimulant if administered when the proper indication exists. Conversely, it may produce much harm if used without discretion.

We have particular reference to the intracardiac injection of epinephrine. This mode of administration of the drug is too frequently used. It is given in such a routine manner that no possible forethought could be given to the indications and contraindications for its use. The danger in the indiscriminate use of epinephrine as a stimulant in acute cardiac standstill has been stressed repeatedly.[33,34,55,85,90,91,109,110]

The failing heart is an irritable and excitable heart. The stimulation produced by the administration of the drug may be the factor in the production of ventricular fibrillation and death.

The efficiency of the drug in resuscitation of the stopped heart is of doubtful value. Primrose stated,[91] "Adrenalin is of little use in restoring the heart beat. It cannot initiate pulsations although it may produce ventricular spasm." In the experience of Bailey:[4] "Not once in 40 instances has an injection of adrenalin into the heart caused it to restart beating." One editorial stated,[33] "If the patient revives after such an intracardiac injection he would have revived without it." It is the opinion of Henderson[55] that; "One puncture will certainly not start an asystolic heart to beating again." Wiggers[110] advises that intracardiac adrenalin should be used with a great deal of caution if ventricular fibrillation is to be avoided following acute cardiac dilatation.

The experimental investigations of Danielopolu and Marcou,[27] on the exposed heart of the dog, demonstrated conclusively the inefficiency of the intracardiac injection of epinephrine in initiating cardiac contractions once complete cessation of the heart beat had occurred. In those experiments in which there was marked enfeeblement of the heart beat without standstill, increase in the force of contractions was obtained with epinephrine. The same authors concluded that epinephrine was amphomimetic in action. The sympathomimetic action predominates in the normal heart, but in cardiac syncope, parasympathomimetic predominance occurs which inhibits the heart. This latter effect was overcome by the use of atropine prior to the intracardiac injection of epinephrine. The atropine renders the action of the epinephrine solely sympathetic.

Despite these views to the contrary the use of epinephrine in cardiac resuscitation has received ample support. It was the opinion of Fantus[37] that: "Intracardiac injection is the simplest and most certain method to cause the motor of the circulatory apparatus to resume motion and to effect resuscitation." He further stated: "Quite as important is its harmlessness even when injected into the heart muscle itself." These statements are not supported by clinical and experimental observations.

Vogt[106] favored the use of epinephrine by intracardiac injection. He reported fifteen cases with full recoveries in which there had been respiratory standstill for five minutes. In Bodon's[12] series there were twenty-three permanent successes in ninety cases. Guthman, Fraenzel and Vogt (1921) obtained twenty complete recoveries in sixty-six cases. Similarly, Raesche, Meyer, Petseloki, Goupuy, Meriel, O'Donovan and Seelheim reported favorable results with the use of this procedure. In a review of the literature Hyman[61] reported complete recoveries following acute cardiac standstill in 25 per cent of the cases in which the intracardiac injection of epinephrine was performed. To obviate the danger of producing ventricular fibrillation, he advocated the selection of the right auricle as the site of injection. If auricular fibrillation should occur, it would not be incompatible with life and would be amenable to therapy.

Epinephrine has not been the only drug which has been used. Bianchetti,[14] using caffeine, reported a complete recovery in a case in which cardiac standstill had been present for twelve minutes. Wieschowski also reported good results with caffeine. Immerman utilized 10 per cent glucose. Ronzini employed a mixture containing lobeline, atropine, adrenalin and pituitary extract. Others with equal success used

camphor, coramine, metrazol, strychnine and hypertonic solutions.

The good results reported with the use of so many and varied medications, leads one to believe that recovery was coincidental and not dependent upon the particular drug administered. The mechanical stimulus produced by the point of the needle has been claimed for the particular successes reported. This conception is not new. For several centuries the orientals employed stimulation of the myocardium by a needle point in cases of syncope or apparent death.

In review of the data accumulated and our own experience, it is our opinion that the intracardiac injection of epinephrine is of no value in restoring the heart beat once complete standstill has occurred. If it is used in a failing and enfeebled heart, ventricular fibrillation is most likely to ensue. Epinephrine should be used as a supplementary aid to massage in resuscitation of the heart. It is a drug which possesses definite therapeutic value, but its indiscriminate use as a stimulant in acute cardiac standstill is condemned.

A consideration of the utmost importance pertains to the use of epinephrine in conjunction with certain of the anesthetic agents.

Levy[68] demonstrated that chloroform sensitized the heart of the cat to epinephrine with production of ventricular tachycardia and fibrillation following its administration.

Meek, Hathway and Orth[80] compared the effects of ether, chloroform and cyclopropane upon the cardiac automaticity. They concluded from their experiments on dogs that cyclopropane rendered the ventricular automatic tissue more susceptible to epinephrine than either chloroform or ether. The latter had the least sensitizing effect.

The action of chloroform differs from cyclopropane dependent upon the plane of anesthesia. Chloroform sensitizes the heart during light anesthesia, whereas cyclopropane has its sensitizing effect during deep anesthesia.

A point of particular importance referable to cyclopropane anesthesia is the protective action of procaine hydrochloride in the prevention of ventricular fibrillation. It has been shown[18,76,80] in dogs anesthetized with cyclopropane, that if procaine is administered prior to or simultaneously with epinephrine, the incidence of ventricular fibrillation is markedly diminished. This drug reduces the sensitivity of the cardiac muscle and concomitantly raises the threshold for stimuli capable of producing fibrillation.

The intracardiac injection of procaine is also efficient in the treatment of ventricular fibrillation. In one series of experiments reported[18] a restoration to normal rhythm occurred in 66 per cent of the animals so treated.

The sensitizing effect of cyclopropane upon the heart has been repeatedly confirmed. It is justifiable to conclude that the administration of epinephrine during the course of cyclopropane anesthesia is an extremely hazardous procedure.

Hyman[63] advocated the use of an artificial pacemaker to provide an electrical stimulus to the heart. The pacemaker consists of a needle through which electrical impulses are transmitted to the auricle at a regular and controllable rate. The stimulus provides a focus from which stimuli may pass through the heart over its normal pathways. He presented experimental and clinical data to justify its use. The method is ingenious and may have merit. However, further general experience with it will have to be obtained before an opinion may be expressed relative to its merit in cardiac resuscitation.

Manual Massage of the Heart. This is the method of choice in resuscitation of the heart. The chance for complete success depends on the interval of time between cessation of the heart beat and the commencement of massage. This is the main factor which determines success or failure.

Cardiac massage, to be successful, must of necessity be performed early.

The value of cardiac massage in the production of an artificial circulation has been adequately demonstrated by Gunn.[51] He injected a solution of a blue-green dye into the cacity of the right ventricle of an arrested heart. Manual massage of the heart was then performed and followed a few compressions the dye appeared first in the lungs and then in the carotid artery. Massage had, therefore, propelled the dye from the right ventricle through the lungs, the left side of the heart and into the systemic circulation.

This brings up a concept of fundamental importance which we again wish to stress. The duration of cardiac standstill is calculated, not from the time that the heart ceases to beat and the restoration of a spontaneous rhythm, but from the time of cessation of the heart beat and the institution of an artificial circulation by cardiac massage.

Mode of Action of Heart Massage. As described by D'Halluin, manual massage of the heart favors: (1) depletion of the heart chambers, distended with blood; (2) acts as a mechanical stimulus to the heart; (3) produces an artificial circulation capable of maintaining adequate nourishment until a normal spontaneous rhythm is resumed.

Methods of Massage. There are three methods of approach in the performance of cardiac massage: (1) Transperitoneal subdiaphragmatic; (2) transperitoneal transdiaphragmatic, and (3) transthoracic.

Transperitoneal subdiaphragmatic: This has been the method most frequently used and the one which claims the highest number of complete successes. It is the preferred method of the majority of writers on the subject.

Since many of the cases of acute cardiac standstill occur during the course of an intra-abdominal operation, subdiaphragmatic massage can be quickly and readily accomplished. This is a distinct advantage since the all important factor, time, is saved with the resulting increase in the percentage of complete recoveries. The exact number of successes by this method cannot be calculated since it has no doubt been performed many times with success but the cases have not been reported.

There are certain disadvantages which this method possesses that deserve mention: (1) The apical portion only of the heart can be reached; the attempts at compression produce an incomplete emptying of the dilated heart chambers. (2) It is conducive to early fatigue of the operator (3) There is a lack of direct visualization of the heart. (4) One is unable to apply drugs directly to the surface of the heart to reduce the sensitivity if the necessity should arise. (5) It is more traumatizing due to the greater force of compression necessitated. (6) There is a relative high incidence of failure, cases recovering following direct massage after the subdiaphragmatic method had failed.

Transperitoneal transdiaphragmatic: In this procedure an opening is made in the diaphragm through which the hand may be inserted directly into the pericardial sac or adjacent to it and massage performed. To avoid injury to the superior epigastric or musculophrenic artery and to facilitate closure, Bost[13] advocated the use of a transverse incision in the diaphragm close to the costal margin. Nicholson[84] made an opening only large enough to admit the thumb. The heart was then massaged between the thumb and the fingers, the latter being subdiaphragmatic. Each author reported instances in which they met with success following failure of the subdiaphragmatic method. Except that the massage is more complete, this method possesses the same disadvantages as the subdiaphragmatic method.

Transthoracic method: This was the method used by Niehaus in his unsuccessful attempt and Ingelsbrud in his successful resuscitation of the human heart. Its use in subsequent cases resulted in a high incidence of failure and was universally condemned. In review of the cases in which it was employed the condemnation was not

justifiable. The interval of time between cardiac arrest and massage of the heart was so prolonged as to preclude successful resuscitation by any method.

The early fear of producing a pneumothorax was an additional causal factor in its fall into disrepute. However, due to the recent advances made in our knowledge of the physiology and pathologic physiology of open wounds of the thorax, in anesthesiology and thoracic surgery, this fear is no longer tenable. This method of approach in our opinion is the one of choice. Its advantages outweigh any disadvantages which it might possess.

In the earlier reports the heart was exposed by elevating a rectangular pericardial flap. This was time consuming and presented certain technical difficulties. Exposure of the heart through a transverse incision in the third or fourth interspace is adequate and readily performed. The incision extends from the anterior surface or left border of the sternum, transversely to the left nipple or anterior axiliary line. The incision is deepened through the underlying fascia and muscle layers and the corresponding intercostal space. The adjacent costal cartilages above and below are sectioned and the corresponding ribs widely retracted. Everything is now in readiness to begin cardiac massage. The production of a pneumothorax is avoided if possible, but it is of no undue consequence if it should occur.

Technic of Massage. A preconceived plan of therapy, so strongly advocated by Bailey,[4] is conducive to calmness and proper organization of the personnel referable to their individual duties. One person should be delegated time keeper, another to prepare medications, the anesthetist to supervise maintenance of artificial respiration, administration of parenteral fluids, etc., and an assistant to prepare the operative site. Undue delay in the preparation of the latter should be avoided.

Rhythmic manual massage of the heart is performed prior to the opening of the pericardial cavity. In this way no unnecessary time is lost in the establishment of an artificial circulation to supply the immediate tissue needs of the body. Massage is continued for two to three minutes; the pericardium is then opened and direct massage of the heart performed.

The heart is cupped in the hand with the apex directed toward the base of the palm. The fingers are inserted posterior and the thumb anterior to the heart and rhythmical compression performed. The compression should be slow and regular (equaling approximately half the normal rate or about forty to fifty times per minute) and the relaxation abrupt. A slow rate of compression allows a more complete filling of the heart with an increase in the stroke and minute volume output. This results in an increased efficiency of the artificial circulation.

The massage of the heart should be interrupted at regular intervals to encourage a spontaneous rhythm, which continuous massage does not offer. It often happens that when the massage is interrupted, the contractions will gradually become weaker and if manual compression is not immediately begun arrest of the heart beat will occur. If this feature should recur more than once, the combined intramural and intraventricular injection of epinephrine or some other sympathomimetic drug will prove most efficacious in increasing the strength of contractions. Prior to its use, however, a necessary precaution must be taken. The failing heart is a highly sensitive organ. Five cc. of a 2 per cent novocaine solution should be injected into the cavity of the right auricle or ventricle and diffused through the heart by massage before the injection of epinephrine. The novocaine produces a dimunition in the irritability of the heart and lessens the possibility of a complicating ventricular fibrillation. Atropine ($\frac{1}{75}$ gr.) has also been used for the same reason.

Warm saline solution should be frequently applied to the surface of the heart. Heat produces cardiac acceleration, increases conductivity and shortens the

refractory period. Furthermore the solution prevents tissue dehydration.

Ventricular fibrillation is a formidable complication in resuscitation of the heart and demands immediate corrective measures to obviate a fatal outcome. Several modes of therapy have been described but there is no one method which is specific. One of the earliest methods used in the experimental animal was the injection of a solution of potassium chloride (1 per cent) into the carotid artery toward the heart so as to perfuse the coronary arteries. It has also been administered by intracardiac injection. The action of the potassium ions on the heart produced a complete and absolute standstill, the latter occurring in the diastole. An attempt was then made to restore normal rhythm by the injection of calcium chloride (1 per cent).

Massage alone has been used in combating fibrillation of the ventricles and has met with some success in animal experimentation.

The topical application of metycaine (10 per cent) and novocaine (5 per cent) to the surface of the fibrillating ventricles was first described and employed successfully by Mautz[77] and confirmed by Beck.[8] These authors reported repeated successes in dogs and its value is suggested by similar results in the human. Cocaine (4 per cent) also may be used. (Case 11.) The beneficial effects of these drugs results from the reduction in the irritability of the myocardium. This elevates the threshold of the heart to incoming stimuli so that the minimal stimulus which produces fibrillation is ineffective.

Finally, there is the method of electrical countershock. Prevost and Batelli[90] (1899) were the first to demonstrate the value of this procedure in arresting ventricular fibrillation in the experimental animal. The fibrillation was induced in the normal hearts by the passage of an electrical current of forty volts. A return to normal rhythm was effected by cardiac massage and the subsequent passage of an alternating current of two hundred forty to four hundred eighty volts through the heart. The period of circulatory arrest was assumed to begin with the fibrillation and end with the beginning of massage.

The basis for the use of the increased voltage was to produce a stimulus strong enough so that a simultaneous contraction of all the cardiac muscle fibers occurred with momentary inhibition of heart action. Following the termination of the refractory period the heart would then be more susceptible to a normal rhythmic response.

This work was confirmed by Hooker.[58,59] In his animal experimentation he found the short electrical countershock the most effective. A current of 1.0 ampere applied for 0.1 second through an alternating current of sixty cycles is just as effective as when applied for five seconds. By this means he was able to establish repeatedly a normal cardiac rhythm in the same preparation if the fibrillation had not persisted beyond two minutes. If longer than this, a spontaneous recovery of effective beats did not occur and massage of the heart was necessary to restore cardiac rhythm. The longer the period of fibrillation the less the chances are of successful resuscitation.

Wiggers,[110] using the method described by Batelli, of massaging the heart before the application of the electrical countershock, was able to restore normal cardiac rhythm in forty of forty-seven dogs in which fibrillation of the ventricles had existed for five to seven minutes. The preliminary massage produces an artificial circulation through the coronary arteries and overcomes any existing ischemia of the cardiac fibers.

Beck and Mautz[8] reported similar successes and encouraged by the results obtained in the experimental animal, Beck[7] considered its application to the human. He was the first to employ this method in man and reported the first successful defibrillation of the human heart.

The technic employed in "shocking" the heart to overcome fibrillation is that advocated by Beck.[7] Manual massage of

the heart is performed first to overcome cardiac dilatation, increase the tone of the heart muscle, and restore the coronary circulation. Two padded silver electrodes (25 sq. cm.), well moistened in sterile saline solution are applied to the surface of the heart, one anterior, the other posterior. An electrical current of one to one and one-half amperes, through a sixty cycle alternating current is applied for a fraction of a second (0.1–0.5 seconds). As a result the heart muscle is uniformly contracted and brought to a complete standstill. Upon relaxation a normal rhythm may be resumed. However, if fibrillation persists the procedure should be repeated.

Prior to the application of the second "shock" manual massage should again be performed and 5 cc. of a 2 per cent procaine hydrochloride solution injected into the cavity of the right ventricle to reduce the tone and irritability of the heart. If the restoration of a normal rhythm is not obtained and the heart remains atonic, 1 cc. of epinephrine or 5 cc. of 1 per cent calcium chloride is injected (intramural) into the right ventricle, to increase its tone and contracitility. The previous desensitization of the heart by the injection of procaine hydrochloride greatly diminishes the likelihood of ventricular fibrillation occurring. The "shock" is repeated and the fibrillation is usually overcome. If it persists, this procedure may have to be performed several times to obtain the desired result.

Despite the excellent experimental results obtained in defibrillation of the heart by means of electrical countershock, too little attention has been focused on its application in man. Indeed a more general consideration of its merit should be engendered. To this end, a set of sterile electrodes should be available in the operating room for immediate use when the emergency arises.

Case 1. W. A., a male Negro, age forty-eight years, was admitted to the Long Island College, Surgical Service, Kings County Hospital, August 14, 1940, with a diagnosis of human bite infection of the middle finger of the left hand with abscess formation. On August 14, 1940, incision and drainage of abscess of finger were performed. At 7:20 P.M. cyclopropane anesthesia was started. The induction was unduly difficult and the patient offered strong resistance. At 7:25 P.M. open drop ether was substituted for the cyclopropane but anesthetic difficulties persisted. Incision and drainage of abscess were performed at 7:35 P.M. At 7:55 P.M. cessation of respirations and circulation occurred. Artificial respiration (Schaeffer) was immediately begun and oxygen administered. Caffeine sodiobenzoate (2 cc.) and epinephrine hydrochloride administered intramuscularly at 8:00 P.M. At 8:01 P.M. an intracardiac injection of epinephrine (1 cc.) was given with no response. At 8:05 P.M. pericardiotomy was performed. A transverse incision was made in the third interspace, left, with sectioning of the third costal cartilage and the pericardium opened. At 8:12 P.M. manual massage of the heart was performed by slow, rhythmic compression (fifty per minute) for a three-minute period. The heart continued to maintain a spontaneous rhythm for a subsequent three minutes, but the pulsations gradually diminished in force, necessitating further massage. Artificial respiration was maintained. At 8:15 P.M. epinephrine (1 cc.) was injected into the left ventricle; 0.5 cc. intramural and 0.5 cc. into the ventricular cavity, followed by manual massage. The rate and force of the heart beat increased perceptibly but ventricular fibrillation rapidly supervened. At 8:20 P.M. novocaine (2 cc.), 1 per cent solution, was injected into the right auricle and massage continued. At 8:23 P.M. an intracardiac injection of epinephrine (0.5 cc.) was given and massage continued. Ventricular fibrillation persisted until complete cessation of the heart beat occurred at 8:30 P.M.

Necropsy report showed that the heart weighed 400 Gm. The right ventricle was 0.4 cm. in diameter; the left ventricle was 1.5 cm. in diameter. The coronary arteries were patent and the walls were thickened and sclerotic.

Anatomical Diagnosis: (1) Human bite infection, middle finger, left hand; (2) dilatation of heart; (3) pulmonary edema, acute; (4) generalized arteriosclerosis.

Cause of Death: Cardiac dilatation and acute pulmonary edema.

Comment. This case is of interest in that following the failure of the usual conservative methods of resuscitation, restoration of cardiac rhythm was obtained by manual massage of the heart. This occurred despite the prolonged interval (seventeen minutes) between standstill of the heart and massage.

The heart prior to massage was motionless, dilated and possessed a flabby consistency on palpation. The danger in the indiscriminate administration of epinephrine was demonstrated by the immediate onset of ventricular fibrillation following upon its injection into the heart.

In review of this case certain changes in the outline of treatment may be recommended: (1) Massage of the heart should have been performed before the pericardium was opened. (2) Novocaine solution should have been injected prior to the administration of epinephrine, to desensitize the heart. This assumes particular importance when cyclopropane anesthesia is used. The use of a 2 per cent solution (5 cc.) of procaine combined with the topical application of a 5 per cent solution, would have been more satisfactory in the treatment of the fibrillation. (3) Massage of the heart should have been performed earlier. The main factor productive of failure in this case was the prolonged interval (seventeen minutes) between cardiac standstill and massage. If it has been decided that cessation of circulation and respiration has occurred, the immediate performance of cardiac massage is mandatory if complete recovery is to ensue. It is only in this way that our percentages of complete successes may be increased.

Case II. This case is reported in detail because of the interesting diagnostic problem which it presented.

J. S., a male Negro, age fifty-nine, was admitted to the Long Island College, Surgical Service, Kings County Hospital, on May 7, 1942. The chief complaint upon admission was epigastric and low back pain. The only significant finding in his past history was that he had a thryoidectomy performed in 1937. Subsequent to that he developed persistent weakness and nervousness.

The present illness dated back two years (1940), when he noted a sense of fullness in the epigastrum and occasional attacks of pain. Anorexia and constipation were associated symptoms. There was no nausea or vomiting. At approximately the same time he noted a painless lump in the left side of his neck in the outer portion of the thyroidectomy scar.

One year prior to hospitalization a small painless mass appeared in the epigastrium. It increased gradually in size and upon admission occupied the whole of the epigastrium. Four months prior to hospitalization he developed epigastric pain with radiation along the left costal margin to the back. The pain was aggravated by the ingestion of food. Periodic attacks of dizziness, weakness and free perspiration were present for one month prior to admission. A weight loss of twelve pounds occurred during the course of his present illness.

Physical examination revealed the patient to be a well developed, well nourished ambulatory colored male, not appearing acutely or chronically ill. The positive finds were related to the cervical and abdominal regions; blood pressure 138/88, pulse 80, respirations 18, temperature 100°F.

A well healed lower "collar" incision was present in the neck. On the lateral third of the scar on the left side, a hard, non-tender, fixed mass 2 by 3 cm. in size was palpable. Two small firm nodes, each approximately 1 cm. in diameter, were palpable in the left anterior cervical chain.

In the epigastrium, extending slightly to the left, was a visible and readily palpable mass 15 cm. in diameter. It was smooth in outline. Downward movement of the mass occurred with inspiration. Palpation revealed it to be of a variable consistency; cystic in some areas, firm in others. No overlying tenderness or muscle spasm were present. In the left costovertebral angle, there was a definite fullness with overlying percussion tenderness.

Laboratory data were as follows: urine analysis: specific gravity 1020; albumen two plus; sugar negative; microscopic examination: negative. Similar findings were reported on repeated examination. Red blood cells 5,200,000; hemoglobin 16 Gm., white blood cells 5,600; polymorphonuclear neutrophile leuco-

cytes 64 per cent; lymphocytes 36 per cent. Blood chemistry; urea 25; creatinine 1.19; sugar 150.

X-rays were taken of the gastrointestinal area and the following reported: "No intrinsic lesion of the stomach or duodenum. There is a large mass displacing the stomach upward and anteriorly. The mass arises from the region of the retroperitoneal space on the left side. *Conclusion:* Retroperitoneal mass displacing the stomach." *Chest:* "No evidence of metastases. Moderate tortuosity and elongation of the aorta." *Retrograde Pyelograms:* "Retrograde filling of left kidney reveals no irregularity or dilatation of the calyces or pelvis on that side. There is slight elongation of the upper major calyx with tortuosity and elongation of the left ureter as a result of a ptosed position of the kidney. Conclusions: Retroperitoneal mass displacing the left kidney downward, arising from the upper pole of the kidney, the left adrenal or from the retroperitoneal structures themselves." Peri-renal air Insufflation: "Outlines all but the upper pole of a ptosed left kidney. The upper pole merges indistinguishably with a football sized soft tissue mass which extends approximately one inch from an elevated diaphragm (left) to a level one and one-half inches above the crest of the ilium. This mass produces displacement of the neighboring intestinal shadows but appears to be in the retroperitoneal space."

Following upon the completion of the various diagnostic studies the diagnosis of a pseudocyst of the pancreas was entertained and operation advised.

Operation was performed on June 16, 1942, at 9:30 A.M.: "Under satisfactory cyclopropane anesthesia, the peritoneal cavity was entered through an upper right rectus muscle splitting incision. A large mass presenting through the gastrocolic ligament, displaced the stomach upward and the transverse colon downward. The gastrocolic ligament was divided between clamps and the posterior parietal peritoneum overlying the mass was incised. A large, solid tumor mass appeared which was gray-white in color, irregularly nodular and firm to palpation. Many tortuous vessels coursed irregularly over its surface. It extended well to either side of the midline and was considered inoperable. A biopsy was obtained and the wound was closed with through and through sutures of heavy black silk. Further approximation of the skin edges was obtained with interrupted sutures of fine black silk."

Throughout the course of the operation the condition of the patient was very satisfactory. The anesthetic (cyclopropane) was discontinued at 10:20 P.M., at which time the blood pressure was 140/80 and the pulse 88.

At 10:25 A.M. when the last skin suture was inserted the operator (J. L. M.) was informed that neither the blood pressure nor pulse could be obtained. There was no respiratory exchange. Immediate artificial respiration was performed by rhythmic compression of the rebreathing bag, using 100 per cent oxygen. At 10:30 A.M. a transverse incision was made into the third interspace on the left side. The third costal cartilage was sectioned and the pericardium exposed. At 10:34 A.M. manual massage of the heart was performed by slow rhythmic compression, (50 to 60 times per minute) for two minutes. Spontaneous but weak cardiac pulsations were obtained, which persisted for one minute. Manual massage was again performed. Two minutes later 5 cc. of 2 per cent procaine hydrochloride solution was injected into the right ventricular cavity. Massage was continued for another two minutes following which epinephrine (7½ mx) was injected into the wall of the right ventricle. The tone and contractility of the heart increased immediately, but ventricular fibrillation rapidly intervened. Five cc. of cocaine solution (4 per cent) was applied to the surface of the fibrillating ventricles with a medicine dropper. Within two minutes a normal cardiac rhythm was established. Throughout this whole period, artificial respiration was maintained as originally described. A mixture of oxygen, 93 per cent; carbon dioxide, 7 per cent, was substituted for 100 per cent oxygen. At 11:00 A.M. the first spontaneous respiration occurred. Blood pressure was 180/90, and pulse 96. The cardiac pulsations were regular and strong. Warm saline solutions were applied intermittently to the surface of the heart. Artificial respiration was continued and blood transfusion, of 500 cc. was started. At 11:15 A.M. the respiratory rate was fourteen per minute. Respirations were sighing in character and prolonged. Artificial respiration was then discontinued and the cardiac rhythm was normal. The thoracic wound was closed in layers and the patient was transferred to the ward. At 11:30 A.M. the blood pressure was

190/90, pulse 96, respirations 14. Movements of the right arm and head were present. At 12:00 noon periodic and slight muscular twitching movements, more marked in the right side, were noted for the first time. Subsequently, mild decerebrate convulsive seizures occurred which increased progressively in frequency and severity. At 2:15 P.M. the respirations were of the Cheyene-Stokes variety and the pulse was very irregular. The decerebrate convulsive seizures became more severe and death occurred at 2:45 P.M., three hours subsequent to the restoration of the heart beat.

Comment. No medications were employed prior to massage of the heart. In particular the intracardiac injection of epinephrine was avoided until following desensitization of the heart. Despite this precaution ventricular fibrillation ensued shortly after the intramural injection of epinephrine. However, a normal rhythm occurred within two minutes following the topical application of 5 cc. of cocaine solution (4 per cent). The advantage of direct exposure of the heart in the treatment of a complicating ventricular fibrillation was adequately demonstrated.

Artificial respiration was begun immediately following the cessation of the normal respirations. The first spontaneous respiration did not occur until twenty-four minutes following the restoration of a spontaneous cardiac rhythm. The duration of respiratory inhibition bears a direct ratio to the interval of cardiac standstill. The importance of the maintenance of adequate artificial respirations in cardiac resuscitation is well illustrated.

The important point to be stressed in this case, as in the previous one, is the necessity of performing massage of the heart at the earliest moment possible. The exact timing of the events that transpired were carefully recorded by a time keeper. There was a delay of nine minutes between cardiac standstill and the performance of massage. This latter time interval exceeds the generally accepted period of three to five minutes during which complete recovery is possible. The success in this case was partial in that both spontaneous cardiac pulsations and respirations were obtained. However, the anoxia was so prolonged that irreversible changes were produced in the brain cells, which prohibited a complete recovery.

It is most important that the decision to perform massage of the heart be made within the first minute and a pericardiotomy promptly performed. Delay, encouraged by the use of conservative measures and "hopeful waiting" should be avoided if, complete recovery is to be expected.

CONCLUSIONS

1. Acute stoppage of the heart is a surgical emergency demanding immediate action if complete recovery is to be obtained. A preconceived plan of therapy avoids delay and confusion.

2. The percentage of complete recovery in resuscitation of the heart will vary in direct ratio to the time interval between cardiac stoppage and the production of an adequate circulation by massage.

3. The maintenance of a free and adequate artificial respiratory exchange during the course of resuscitation of the heart is essential.

4. The cases of cardiac stoppage, capable of complete resuscitation are those resulting from asphyxia, reflex vagal inhibition, cardiac trauma, cardiac toxins (drugs, anesthetics) acute cardiac dilatation, hemorrhage and vasomotor paralysis with resulting circulatory insufficiency, and electrocution.

5. The indiscriminate use of the intracardiac injection of epinephrine or other sympathomimetic drugs is condemned.

6. Sympathomimetic drugs should not be administered during the course of cyclopropane anesthesia.

7. Procaine hydrochloride (2 per cent) administered prior to or simultaneous with the intracardiac injection of epinephrine lessens the possibility of ventricular fibrillation occurring.

8. The topical application of procaine (5 per cent) (metycaine 10 per cent) or

cocaine (4 per cent) may also be used to the surface of the heart; the injection of the 2 per cent solution into the chambers of the heart and electrical countershock are the most efficiency methods in the treatment of ventricular fibrillation.

9. The transthoracic approach is the method of choice in the performance of cardiac massage. Exposure of the heart is obtained through a transverse incision in the left third or fourth interspace, the adjacent costal cartilages sectioned and the corresponding ribs widely retracted.

10. Manual massage of the heart is the most effective means of initiating cardiac contractions. If uniform success is to be obtained, massage must be performed within three minutes following cessation of the heart beat.

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OSTEOPLASTIC PROCEDURE FOR CORRECTION OF FUNNEL CHEST

RUDOLPH NISSEN, M.D.
Attending Surgeon, Jewish Hospital of Brooklyn
NEW YORK, NEW YORK

THE usual objective of thoracoplastic operations is to *diminish* the size of the thorax in order to assure a permanent collapse of a definite portion of the lung. However, a thoracoplastic procedure to enlarge the thoracic cage is indicated when the areas occupied by the heart and great vessels are encroached upon by pathological processes or structures.

The first attempts in this direction were undertaken as palliative measures in cases of inoperable mediastinal tumors or very large aortic aneuryisms. The sternum was split in two, (Milton[1]), and a wooden or metal wedge inserted between the segments (Sauerbruch[2]), thus enlarging the mediastinal space and relieving the superior vena cava and trachea of excess pressure. Certain deformities of the chest skeleton, the most common in practice being the congenital or traumatic depression of the lower parts of the sternum, "funnel chest," present a more complex surgical problem.

Operative correction for a pronounced condition of funnel-chest is indicated for the following reasons: (1) Non-surgical treatment offers no hope of cure. (2) The deformity causes displacement and twisting of the heart and abnormal pressure upon the right auricle and ventricle with resultant circulatory and nerve-impulse conduction disturbances. (3) The chest skeletal structure in these cases tends to become fixed at an early age, causing a harmful decrease in the potential respiratory excursions. This predisposes to asthma and emphysema and increases the hazard of pneumonia.

In their report to the French Orthopedic Congress in 1934 Ombrédanne,[3]) Garnier[4] and Mathieu[5] presented a detailed discussion of the anatomy, the various clinical features, and the therapeutic measures which had been applied. In 1939, A. Ochsner and M. de Bakey[6] published another review of the literature and gave a case report of a patient operated upon by them.

Garnier[7] describes the surgical advances in treatment as follows:

"The first operations, originated by L. Meyer,[8] consisted in small-scale decompressive chondrectomy. The next step was the resection operation involving the whole depressed sternochondral mass, done by Sauerbruch[9] and by Lexer.[10]* Since 1931 more involved osteoplastic procedures have been introduced by Sauerbruch and Nissen[11,12] in Germany and in France by Ombrédanne, Garnier and Mathieu."

It should be added that in the United States, J. Alexander[13] in 1931 published another osteoplastic method, namely, dividing the deformed sternal segment by a T-shaped split. Any method which failed to alter the faulty anatomic position of the sternum could not be expected to effect a cure. Although division of the costal cartilages, as proposed by Meyer, would permit improved respiratory excursions, the harmful direct mechanical interference with cardiac action would not be relieved.

Complete excision of the deformed sternum and of the adjacent rib segments, first performed by Sauerbruch and Lexer, would decompress the heart, but would

* Ochsner and DeBakey note that in Lexer's case "the sternum was turned around so that the anterior surface became posterior in order to protect the heart." According to the text of Hoffmeister's publication such a procedure may have been planned but was never performed. Lexer apparently realized full well the difficulty if not impossibility to reanchor in this way the transplant in the desired position.

leave the organ dangerously exposed to trauma and to the damaging effect of paradoxical respiratory excursions in the exposed area.

Bakey[13] obviated this by dissecting the depressed segment completely free from its mediastinal and tendonous attachments followed by extension for several weeks.

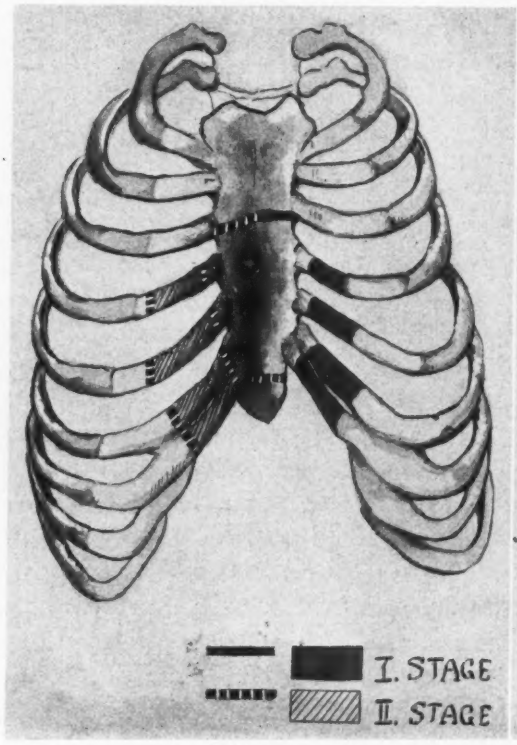


FIG. 1.

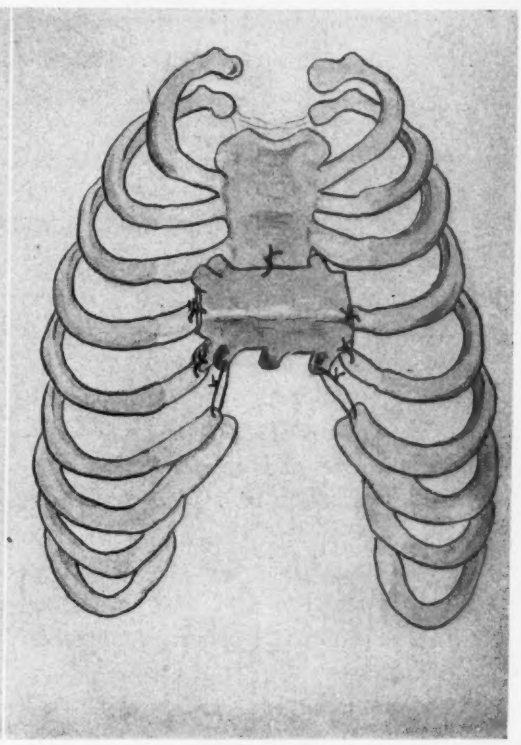


FIG. 2.

FIGS. 1 AND 2. Schematic drawings illustrating the two-stage resection and the final position of the transplant.

In our early operations we attemped to apply an extension mechanism to the sternal segment after its separation from the ribs, so as to anchor it in normal position; but it was found out in a subsequent case, that that was not enough, due to the lack of mobility of the sternum. J. Alexander was fully aware of this disadvantage, because he had already combined traction with the above mentioned T-shaped osteotomy in his early case. Ombrédanne achieved the same mobility by adding a transverse dissection. However, although the sternal segment had been freed from adjacent bone and cartilage its muscular, fibrous, and tendonous attachments to mediastinum, diaphragm and rectus sheaths often prevented permanent stability in the desired position. A. Ochsner and M. de

But none of all these methods establishes firm connection between the lifted sternum and the ribs. Therefore, the faulty position may be resumed later on. A firm, new junction of the lifted sternum and the stumps of the ribs is desirable.

These various considerations led us to plan certain modifications with a view to improving the operative and mechanical end result, as described in the following case history. It offers, incidentally, the advantage of dispensing with the complicated traction.

CASE REPORT

A twenty year old chemist complained of shortness of breath and precordial pressure. His father, one brother and one sister have a mild degree of funnel chest. Examination of

the father in 1937 revealed slight enlargement of the heart and changes in the electrocardiogram indicated mild myocardial damage. The patient's tonsils had been removed twice, otherwise he was never really sick and no other operation was ever performed.

He complained of shortness of breath, a feeling of pressure in the cardiac region, was easily fatigued and had difficulty in maintaining his weight. His appetite was satisfactory. He had a tendency toward bronchitis. Two cardiologists recommended corrective operation for the funnel chest. Dr. D. Scherf referred the patient to us.

Physical examination revealed the blood pressure to be 140/80; heart sounds were normal. The chest showed a very distinct malformation (funnel chest). The inner dimensions of the chest were above average, the width of the thorax being 32 cm., the depth of the thorax being 20 cm. at the site of the nipples and 14 cm. in the middle of the chest. The depression, therefore, at the middle of the chest was 6 cm. deep; respiratory range was 4 cm.

X-rays showed the heart to be of the bowl-shaped type shifted to the left and lifted upward. The mediastinum, too, was shifted to the left, the vena cava not being visible, as is customary, on the right side. Due to the displacement of the heart to the left side, the right hilus shadow appeared more pronounced than under normal circumstances. The measurements of the heart were found to be normal. The apex of the heart was rotated toward the back so that the right ventricle was in contact with the left chest wall to a greater degree than usual. The lateral *x*-ray view showed also that the main mass of the heart was in contact with the left part of the chest wall next to the depression. The retrocardiac space was considerably narrowed. There were no additional important findings in pictures taken in the two oblique diameters. Pictures taken with empty and with filled stomach revealed the following: In the afternoon when the stomach was filled, the heart was shifted farther upward than in the morning; the bowl-shaped configuration was more pronounced, indicating that the right ventricle and not, as usual, the left ventricle, formed the left borderline. The electrocardiogram showed a widened S-wave in lead I, and a widened upward directed S-wave in leads II and III. Thus leads II and III

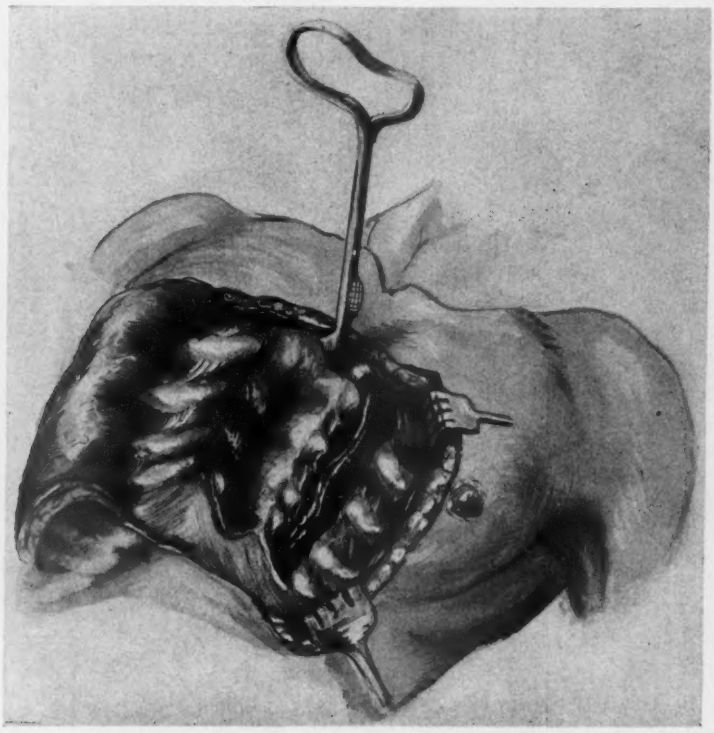


Fig. 3. First stage: Resection of the cartilaginous rib portions on the left side is done. A special chisel is driven half way across the sternum. The course of the internal mammary vessels is indicated.

appeared to be splintered. T in lead III was inverted. The chest lead C R-5 showed a slightly widened S-wave. The question must remain

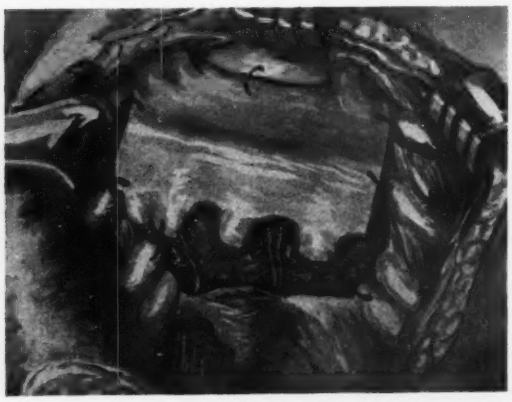


FIG. 4. Second stage: After complete dissection the depressed part of the sternum is fastened in such a way that the originally long diameter is now horizontal and the originally posterior surface points anteriorly. The transplant is sutured to the rib stumps and to the upper part of the sternum. The xiphoid processus is left in place.

open whether the changes in the electrocardiogram were due to myocardial damage of the right ventricle or whether they were only the consequences of the cardiac rotation and the shift of the heart to the left and backward.

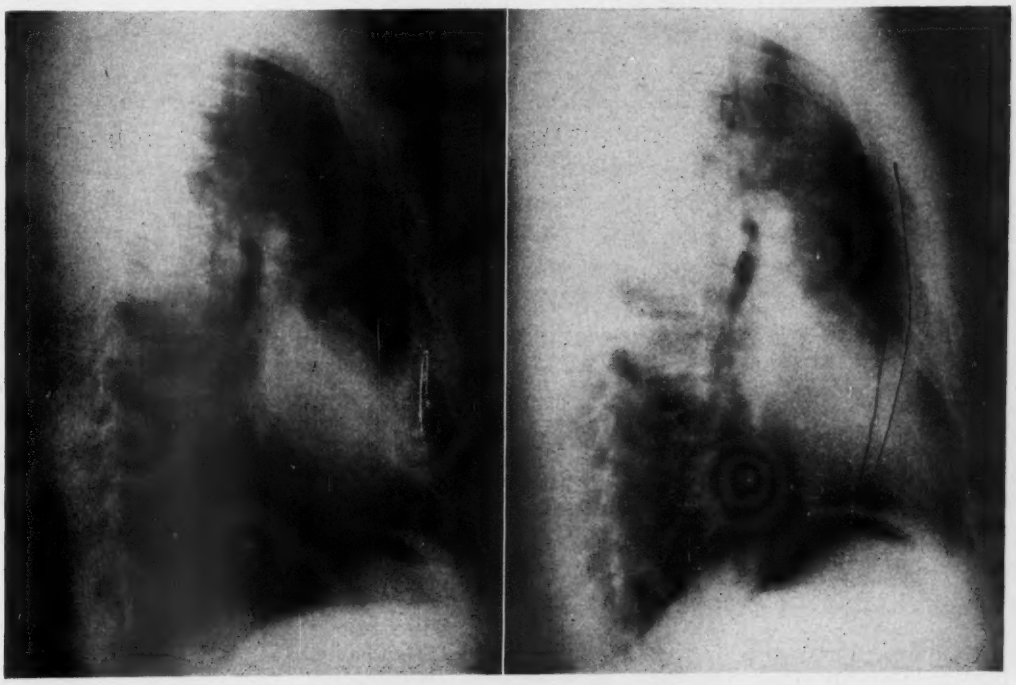
The blood count showed a hemoglobin of 109; red blood cells 5,200; white blood cells 6,200; polymorphonuclears 56, leucocytes 40, monocytes 3, eosinophiles 1; urea nitrogen 22.7; creatinine 2.1; uric acid 3.7; glucose 80; carbon dioxide combining power 55.7 volume per cent; basal metabolism rate minus 14.

After three months' observation, operation was decided upon. The first stage of the operation was performed on November 5, 1943, (intratracheal cyclopropane anesthesia). A rectangular skin flap was formed with the long side running parasternally, along the corpus sterni on the left with the two horizontal incisions ending at the opposite parasternal line. After reflecting the flap toward the right side, the third rib was exposed, stripped of its perichondrium, and resected laterally from the sternocostal junction for about one inch. The same procedure was performed on the fourth, fifth, sixth and seventh ribs. During the manipulation of the third costosternal junction the onset of auricular fibrillation was noted. The pulse rate was 120 to 140 per minute for about seven minutes. It was noticed that immediately after severance of the ribs the sternum attained a much more normal position. With the resection of this side completed, it was also noticed that the heart quieted down and appeared freed from a mechanically embarrassing situation. In concluding this stage, the corpus sterni at its upper end was chiseled across as far as the midline (Figs. 1 and 3.) Closure of the wound was by muscle sutures, subcutaneous and skin sutures. The patient had an uneventful recovery.

The second stage of the operation was performed on November 19, 1943, (intratracheal cyclopropane anesthesia). The old incision was reopened. After reflecting of the skin flap, the attachments of the fourth, fifth, sixth and seventh ribs were severed parasternally in much the same way as was done previously on the opposite side. The sternum was then chiseled across at the level where it had been begun at the first stage. Contrary to expectations, the sternum could not be lifted freely after complete transverse section. This was due to the fact that the pericardium was densely adherent to the posterior surface of the sternum. These adhesions had to be separated by sharp dissection. The lower end of the sternum was cut across with the bone cutter, leaving the ensiform process in place. The main part of the corpus sterni measuring about two and one-half inches on the side and one and one-half inches across had thus become a free transplant. It was then rotated 90 degrees so that the long diameter lay horizontally and the short diameter vertically. Thus, the transplant rested on the rib stumps and could not slip back into its old position. It was fastened by silk stitches to the rib stumps. (Figs. 2 and 4.) At first there was a considerable space between the mediastinum and the posterior surface of the reimplanted segment of the sternum. Filling of that space by a free graft of fat tissue was considered, but the heart slowly moved closer to the sternum transplant and the idea of a graft was abandoned. The wound was closed with subcutaneous and skin sutures.

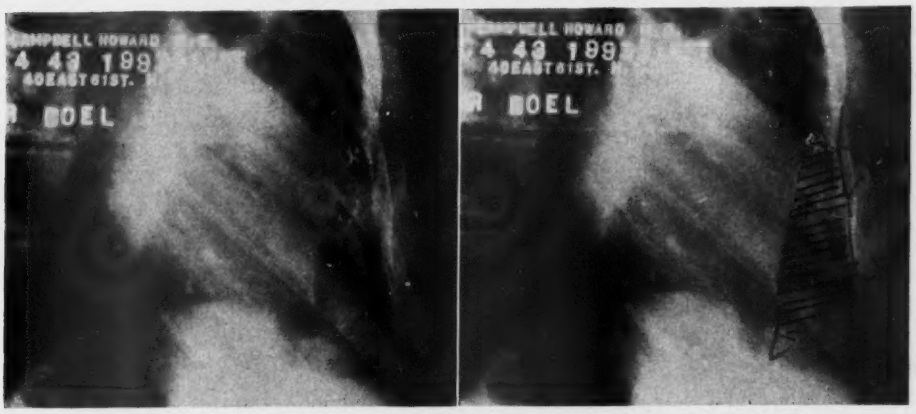
On the second day after the operation, there was a temperature rise to 101°F. with signs and symptoms of atelectasis of the right lower lobe. On the fifth day, the temperature returned to normal. Healing of the wound was uneventful. The patient left the hospital on the fourteenth postoperative day and his general condition was satisfactory. The sensa-

tion of compression in the cardiac region had disappeared. Respiratory range on March 4, 1944, had increased to 11 cm. *X*-ray picture changes in the mechanics of respiratory function secondary to the parasternal section of the ribs proceed by gradual stages,



A B

Fig. 5. A, preoperative *x*-ray showing the depressed sternum; B, same picture as in A with the sternum outlined.



A B

Fig. 6. A, postoperative *x*-ray showing the situation of the transplant; B, the same as in A with the sternum outlined; shaded area indicates the gain in precardial space.

taken on the twelfth postoperative day reveal the desired mechanical result of the operation. (Figs. 5 and 6.)

Various objections might be raised in a critical examination of the operative procedure described above. It may be argued that doing the operation in two stages is unnecessary. We believe, however, that the and lungs and heart should be given adequate time to become adapted to the new conditions.

Moreover, there is the danger of injury to the pleura. This is admittedly very likely to happen even though all possible precautions are taken. The damage may be done without there being any manifest

evidence of it. The most important clinical sign, namely, the appearance of air bubbles in the wound, is not infallibly diagnostic of pleural injury, for the bubbles may arise from the mediastinum itself due to respiratory changes in pressure. Because recognition of the occurrence of this complication of pleural injury is often so difficult, there would be danger of overlooking bilateral wounding of the pleurae if the operation were done in one stage.

Another debatable point is the question of whether or not to remove the xiphoid. As this portion of the sternum has no attachments to the ribs and does not lie in the immediate vicinity of the heart, its presence has no bearing on the mechanics of the operative result. To excise it from its connections with the diaphragm and rectus sheaths would unnecessarily complicate and prolong the procedure.

The empty space which may exist between the heart and the transplant has been mentioned in the account of the operation. In our case the heart spontaneously moved over to fill this area. If this should not happen in other cases, it will be necessary to transplant a piece of fat tissue into the cavity, despite the obvious drawback of utilizing two free transplants, one of bone and one of fat, at one operation. But to leave the space open would invite the danger of infection in the blood or serum which would collect there.

Finally, it may be argued that if the operation is done in childhood, the resected sternal transplant will not grow proportionately to the rest of the chest skeleton. The opinions of various observers differ as to the growth-potential of free autotransplants of bone, but the majority hold that a moderate degree of growth does occur. Because of the position in which the sternal transplant has been fixed in our method, growth would proceed primarily in the horizontal direction, and thus probably decrease the danger of a separation between transplant and ribs as the thorax enlarges.

We do not believe it advisable to undertake the operation in early childhood when the risk is much greater than later on. It would only be indicated in the early years if serious circulatory symptoms were to make an attempt at surgical relief imperative.

SUMMARY

A method for osteoplastic correction of funnel chest is presented which is believed to avoid the disadvantages of previously described operations. The pros and cons of the various steps in the procedure have been discussed.

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SYPHILIS AND PREGNANCY

WILLIAM T. DAILY, M.D.
Assistant Obstetrician and Gynecologist, Long Island College Hospital
BROOKLYN, NEW YORK

IN 1905, Schaudinn, a protozoologist, looking through a microscope, saw the Spirochæta pallida and announced the etiology of syphilis. Two years later Wassermann, Neisser and Bruck developed the serological test, making the diagnosis possible. In 1910, Ehrlich stated that the infection could be cured with salvarsan.

Preventative medicine probably never has been favored with three such epoch-making researches as the three announced during those five years. Armed with these excellent weapons, much should have been accomplished but relatively little has been done in the prevention and treatment of syphilis in the pregnant woman. There would be no infected newborn babies if their mothers were free of syphilis.

Parran has stated that 60,000 babies are born in the United States every year with congenital syphilis. Our rate for congenital syphilis alone is twice as high per thousand of our population as is Denmark's rate for syphilis of all types. The incidence of syphilis in obstetrical clinics varies from 1 to over 30 per cent. There is wide variation in the incidence of the infection in clinics of the same city, depending upon the difference in the clinic clientele.

A complete physical examination often gives no indication that the pregnant woman has syphilis. A chancre, during gestation, has not been seen in our obstetrical clinic during the past nine years. An infective lesion of the vulva would probably be noted by the patient. The vagina is rarely involved due to the protection of the stratified squamous epithelium. The cervix is the most common location of the chancre. The Fallopian tubes are rarely involved and the ovary practically never.

Unfortunately, unlike gonorrhea, which causes sterility, the syphilitic woman is as fertile as the nonluetic.

About eight days following fertilization, the ovum becomes implanted in the decidua. The corpus luteum develops and reaches its greatest growth at the third month. At this same time the placenta begins to function. The trophoblast is soon differentiated into an active layer of Langhans and a syncytium. In the middle of pregnancy, the Langhans' layer thins out and finally disappears, leaving a thin syncytium. Possibly, the two layers, which early are luxuriant and active, act as the barrier which prevents the spirochæta from invading the fetus before the fifth month. In only one case, Trincisse found the spirochæta in the Langhans' layer; however, in ten cases the organism was noted in the syncytium. Fetal infection after the fifth month is common. Pregnancies which terminate in the first trimester occur as frequently in the serological negative group as in women with a positive serology. It therefore is believed that spirochætal infection does not cause an early abortion. The organism has not been recovered from an early fetus.

The absence or mildness of syphilitic infection during pregnancy suggests the probability of a beneficial effect during gestation.

Brown and Pearce injected a testicular emulsion of Spirochæta pallida intradermally in eight pregnant rabbits, and into an equal control series of three normal females, two females in heat and three males. Definite lesions with marked adenitis were present in all the controls at the end of the third to the fourth week. Four of the eight pregnant females inoculated in the same way failed to show any evidence of infection. Three showed slight infiltration at

the site of inoculation with no lymphadenitis. The one successfully inoculated pregnant rabbit was in the middle of her pregnancy.

Likewise, in women, there is apparently a protective mechanism, and this is especially true in those women who have become pregnant since their infection.

White and Davis, in their study of cardiovascular syphilis noted male infection to be five times more common than in the female. Turner observed both cardiovascular and neurosyphilis to be over twice as frequent in male as in female patients. Moore noted a lower incidence of neurosyphilis in women who had become pregnant since infection than in those who had not. Solomon, studying pregnancy histories in 559 syphilitic women admitted to the Boston Psychopathic Hospital, found that 44 per cent of those with cerebrospinal syphilis had never been pregnant, and concluded that women with this lesion were either infected with a severe neurotrophic strain of organism which affected child bearing, or that women who had become pregnant received some protection against neurosyphilis. The Cooperative Clinic Group, reporting the results of treatment in 591 cases of latent syphilis in females, noted 42.4 per cent of 283 who were pregnant obtained a satisfactory result, while only 29.7 per cent of 303 nonpregnant women had a favorable outcome; 18.4 per cent of the former and 42.2 per cent of the latter were Wassermann fast.

DIAGNOSIS

In taking histories of syphilitic women, it is surprising how few are aware of their infection. To depend solely on the patient's observation of primary or secondary lesions would result in the failure to treat about 90 per cent. Since practically all are masked or in the latent stage, the diagnosis must be made by a routine serological test.

While there is no typical syphilitic obstetrical history, succeeding pregnancies often tend to be carried nearer to term. Late abortions, premature or full term stillbirths should arouse suspicion and an effort made to determine the cause of fetal death. All syphilitic mothers do not transmit the infection to their children, even if untreated. The time element from maternal infection to the delivery of her child is important. The older the infection, the less virulent it is. There is, therefore, less chance of transmitting the spirochæta to the child in utero. If the baby is luetic, the mother also is luetic. The father may or may not have the infection. In this state until 1938, when premarital serological tests were made a prerequisite to marriage, both contracting parties could have been syphilitic, neither having necessarily infected the other. In our clinic, 50 per cent of the husbands of patients receiving prenatal syphilis therapy had neither a positive serology nor gave a history of treatment.

Unfortunately, too much emphasis has been placed on the so-called false positive of pregnancy. Following the development of the Wassermann test many conditions were thought to give a positive reaction. Among these were tuberculosis, malignancy, pregnancy, anesthesia, diabetes, scarlet fever and jaundice. However, as the technic of this test has improved, and trained serologists have become responsible for its interpretation, the incidence of false positive reactions has markedly decreased. Hinton did serological tests on 3,701 U. S. Naval aviation students. Only .56 per cent gave a positive reaction. However, of 862 inmates of The Massachusetts Reformatory for Women whom he studied, 40.49 per cent gave a positive reaction. Eagle tested the blood of 1,000 medical students, nurses and hospital employees, and only one was positive. An examination of this person revealed a chancre. A positive serological test performed by a competent serologist, especially if repeated, means syphilis.

Fordyce and Rosen believed that a Wassermann test done on blood taken just

before delivery is unreliable, and that a weakly positive reaction may occur in normal women during pregnancy. In this connection, 200 women having a negative blood serology in the prenatal clinics at the Kings County Hospital and The Long Island College Hospital were investigated. Blood was taken in the group during labor and tested by the Wassermann complement fixation technic, using two different cholesterolinized antigens. At Kings County Hospital all reports were negative. A parallel group tested by two different flocculation tests, the Hinton and Kline, at The Long Island College Hospital likewise remained negative during labor.

That errors occur in serological investigations is admitted. Incorrect labelling of specimens, errors in typing reports, duplication of names and errors in laboratory technic may be mentioned. Then again, the serum may contain some unusual factor.

Some diseases, such as the following, may possibly give a false positive:

1. *Yaws.* This is an infection closely related to syphilis, caused by the Spirochæta pertenuis. It is non-venereal, although transmitted by contact, affecting chiefly children. It is limited to the tropics. Both complement fixation and flocculation tests will give a positive reaction. Morphologically, the Spirochæta pertenuis cannot be differentiated from Spirochæta pallida.

2. *Leprosy.* A positive serology has occurred in patients suffering from this malady. Investigators have reported marked variations in its incidence. Kolmer and Denny had no false positive reactions in 159 cases. Eagle states that duplicate samples of serum from fifty lepers tested by four modifications of the Wassermann technic and nine different flocculation tests gave from 40 to 76 per cent positive reactions. His series was selected as non-syphilitic.

3. *Malaria.* This disorder shows variations in the reports. In only one series the Wassermann or flocculation test was positive in about 30 per cent. Other reports show less than 1 per cent positive.

4. *Trypanosomiasis.* While this infection has been reported to give a false positive, more evidence is needed.

5. *Relapsing fever* in Europe caused by treponema recurrentis, described by Obermeir in 1868, occasionally gives a confusing reaction.

6. *Infectious Mononucleosis.* It has been noted in this disease that the serum contains an increased amount of heterophile antibody, and a false positive may be caused not by reagin but by an excess of amboceptor.

Before a diagnosis of syphilis is made, the test, if positive, should be repeated. A flocculation, as well as a complement fixation test is valuable. If doubt still exists, repeat in another laboratory. A positive complement fixation and flocculation test indicates that the serum contains reagin, which is a product of infection by the Spirochæta pallida. Eliminating the above mentioned possibilities of false positive reactions, a positive serum which has been confirmed is sufficient evidence for the diagnosis and treatment of syphilis.

PROVOCATIVE

Often one is confronted with a history which does not suggest syphilis yet the blood serology is weakly positive. To institute therapy unnecessarily is unwarranted. On the other hand, failure to protect a fetus in utero of a syphilitic woman is inexcusable. Today, a child has the right to be born without syphilis and may hold the physician responsible for neglect if the infection is not diagnosed and treated.

In doubtful cases of syphilis, we have used as a provocative injection 0.3 Gm. of neoarsphenamine in 10 cc. of freshly distilled water given intravenously. A serological test is done on blood taken one, four and eight days subsequently. If in the tests the reaction has increased from a low to a high one, treatment is indicated in the interest of the unborn child. The

following case may be mentioned as an example of the procedure:

A multipara had an admission serology of 1 plus. The test was repeated showing 2 plus. The provocative injection increased the reaction to 4 plus in the three specimens of blood taken one, four and eight days subsequently. Examination of her two children revealed a positive serology, as did that of her husband. The unborn child, in whose interest the test was performed, was, in the meanwhile, delivered. *X*-ray revealed positive leutic long bone changes. The entire family has syphilis and is now undergoing treatment.

It has been stated that, in the absence of syphilis, the injection of an arsenical would change a negative serology to a positive one. This has not been our experience. Recently, in the Prenatal Clinic of The Long Island College Hospital, we routinely gave this provocative injection to 400 pregnant women with negative Hinton and Kahn tests. Blood taken one, four and eight days after the provocative injection revealed that the Hinton and Kahn tests remained negative in each of the 400 patients.

While, probably, there is no false positive of pregnancy, there may be a false negative. McCord has autopsy material in which the organisms of syphilis were demonstrated in 221 abortions and babies of all periods of gestation. The Wassermann during pregnancy or in labor was negative in 29 per cent of these mothers. In 175 colored stillbirths in all periods of gestation, he noted syphilitic bone changes in thirty-seven babies, or 20 per cent. The maternal Wassermann was negative in sixteen, or 43 per cent.

Whether a husband can infect the fetus directly by Spirochæta pallida in the seminal fluid, while the mother escapes infection, has been discussed for two hundred years.

While an ovum in the Fallopian tube is approached by many spermatozoa, only one shall gain admittance. Where the male cell penetrates the ovum, the vitelline membrane loses continuity and the spirochæta enters. As the walls of the membrane again close, it is so timed that the locomotive portion of the male cell is detached. The ovum is now impervious to all other cells. If the spirochæta were able to enter the ovum with the spermatozoan, its length, about three times that of the active factor of a spermatozoan, would probably be unable to enter completely, and the cytoplasm of the cell would be disturbed by its movements. Slight disturbances of cytoplasm tend to malformation and anomaly. It is infrequent that we find the latter in the syphilitic newborn.

Kemp analyzed his own cases and reviewed the literature of examinations of seminal fluid. Semen of individuals who knew when their infection was contracted was examined for the spirochæta by dark field examination, silver staining or animal inoculation. In sixty-seven individuals, the majority of whom had untreated florid secondary infection or mucocutaneous relapses, treponema were found in thirteen, or 19.4 per cent. However, in fifty-two individuals with late syphilis, only one case showed the spirochæta.

Body fluids, even blood, do not necessarily transmit the infection. Blood transfused into another from donors with a positive serology may or may not transfer the spirochæta. In one case in our clinic, syphilis was transmitted by a donor who had contracted the disease within the previous six months. In another case, an emergency transfusion of blood from the husband was given. The laboratory eventually reported his blood 4 plus, which remained the same on the repeated test. We have followed this recipient for years with many blood tests, and they have all remained consistently negative. The difference in these two cases is one of duration of the infection in the donor. It is not a question of positive serology, but whether, during the actual mechanical transfer of blood from donor to recipient, the fluid contains the spirochæta. McNamara knowingly transfused nine patients with blood of syphilitic donors. Five received blood

by one transfusion; three from two different donors, and one from three donors. In the follow-up of the recipients, neither serological nor clinical evidence of the infection was demonstrable.

TREATMENT

Treatment during pregnancy is directed primarily in the interest of the child in utero. Accordingly, the mother's syphilis is secondary. The limited amount of therapy during pregnancy will have but small effect on the maternal infection.

The fetus apparently is protected against invasion of the spirochæta during the first five months of gestation. McCord failed to find any organism in a dead syphilitic fetus weighing less than 100 Gm., the average weight at the fourth month. It was in the seventh, eighth and ninth-month fetus that the spirochæta was most often found.

Treatment instituted early is directed to *prevent* the infection reaching the fetus. Therapy begun late is intended to *treat* the infected fetus in utero. About 85 per cent of our cases are not seen until the latter half of pregnancy.

Snyder and Speert injected neoarsphenamine in rabbits and noted a progressive increase in the rate of placental transmission of arsenic to the fetus as the pregnancy approached term. After separating the maternal and fetal placental portions, they noted in the fetal part a total amount of arsenic six times as great as in the maternal portion. Within an hour following injection into a rabbit at term, a placental study revealed a larger amount of arsenic in the placenta than was transmitted to the fetus. Gradual liberation of arsenic from the placental reservoir to the fetus was revealed by the much higher content of arsenic in the fetus twenty-four hours following injection.

In four pregnant women receiving neoarsphenamine, Kraul and Bodnar noted arsenic in the three fetuses born in the latter part of pregnancy. In the fetus born at the sixth month, no arsenic was found. That arsenic or its derivatives pass the placental barrier was observed by Eastman, who found a relatively large amount in the meconium and a relatively small amount in the blood of a newborn.

Too often, a patient seen late in pregnancy fails to receive treatment because it is believed that no benefit will result. It is never too late to treat, even though the chances are in favor of fetal infection. A relatively small amount of the arsenical given late in pregnancy is more efficacious than when given in the first five months.

From the obstetrical viewpoint it would be in the interest of the fetus in utero to assume the dictum that once a syphilitic mother, always a syphilitic mother. While it is true that those who have been well treated would probably deliver non-syphilitic children, it is apparent in taking histories on infected mothers that a large number have received inadequate treatment. Even if the Wassermann be negative, the patient may have a syphilitic child.

In spite of the extra load upon the emunctories, the pregnant syphilitic mother tolerates treatment well. By keeping alert for obstetrical complications and realizing the potentialities of the arsenicals, the dangers of therapy are slight. Blood pressure recordings and urinary analyses should precede each injection. If the patient is toxic, treatment should be withheld. Contraindications to treatment based on constitutional diseases play but a small part. Rarely have we seen a pregnant luetic woman unable to tolerate treatment.

Meta-aminoparahydroxyphenylarsine oxide or mapharsen, developed by Tatum and Cooper, is being used exclusively in the two clinics. Two hundredths of a Gm. of mapharsen dissolved in 10 cc. of freshly distilled water is injected intravenously in the basilic or cephalic vein. In a week, if the previous injection was well tolerated, .04 Gm. of mapharsen is given. The third week it is increased to .06 Gm., which is the maximum weekly dosage. We believe mapharsen injections could be given more often than each week, and if we encounter a recent infection, showing either chancre

or rash, we would not hesitate to do so. In our clinic 1 cc. of 10 per cent bismuth salicylate dissolved in olive or peanut oil is injected intramuscularly into the gluteal muscle. It was decided about five years ago to give *both* the intravenous and intramuscular on the same visit. This method has proved satisfactory. During pregnancy there are neither courses nor rest periods. The dual therapy is given weekly from the time of diagnosis to the delivery of the child. We are not concerned with too much, but too little treatment.

The injection of protoplasmic poisons is, however, an operation and cannot safely be performed on all pregnant women by everyone.

Previous to the recent interest in syphilis, the incidence of fatalities due to arsphenamine therapy was low—probably no higher than deaths resulting from chloroform poisoning. Meirowsky, secretary to an investigating committee, reported one death in 13,000 injections of old salvarsan, and one death in 162,800 injections of neosalvarsan.

As the chemistry and pharmacology of the drugs have improved, the fatalities have decreased. In the United States, the National Institute of Health, at Washington, determines the total arsenical content, toxicity in white rats, and the trypanocidal activity of each lot of drug, and directs that minimum standards be met before the preparation can be placed on the market. This should have a beneficial effect.

REACTIONS

While there are several types of reactions from the arsphenamines, three are of particular interest:

1. The nitritoid reactions are not uncommon and are primarily of a vasomotor origin. Soon after an injection of arsphenamine, the face flushes. There is a sensation of heat, dyspnea or palpitation. The patient appears anxious. The pulse is weak and there is a drop in blood pressure. She prefers to lie flat. These signs and symptoms do not last long, and are relieved by adrenalin. Nausea and vomiting, particularly in those travelling by trolley car or subway, headache, dizziness and fever may occur and last several hours, forcing the patient to bed.

2. Arsenical dermatitis occurred in two of our cases previous to the use of mapharsen. Both women were colored. General itching is a warning to discontinue therapy, temporarily, at least. This lesion occurs early in treatment. In both cases, a generalized pyodermia was present. The eruption begins usually with a maculopapular or vesicular dermatitis, spreading over the entire body, face, trunk and extremities. In both cases, an intense edema was present. The patients appeared acutely ill. Exfoliation of the skin of the entire body occurs in about three weeks. Often an otitis media is present.

3. Hemorrhagic encephalitis occurs more frequently in pregnancy than in the nonpregnant woman. Cormia noted in forty-six women with this lesion that thirty-four were pregnant. It is a serious and often fatal complication following arsenical therapy. Ehrlich was familiar with this condition and believed it was not due to the drug but to some inherent weakness in the patient's blood vessels. It may also occur following an arsenical injection given intramuscularly. Since the damage is done early in treatment, usually under five and often following the second or third injection, it, apparently, is not an accumulation problem. The syndrome includes fever, headache, irritability, convulsions and coma. Death occurs in a day or two. The pathology is edema and multiple punctate or small ring-formed hemorrhages in the brain. Cormia reported a case in a pregnant woman in whom petechial brain hemorrhages were found not only in the mother but in the fetus as well. It is interesting that patients poisoned by inorganic arsenical compounds show large amounts of the drug in the brain but do not have an accompanying encephalitis.

DIAGNOSIS OF SYPHILIS IN THE NEWBORN

Whether a child born of a luetic mother should be subjected to treatment or await signs or symptoms of the infection is often difficult to decide. The problem becomes simpler if the following methods are considered:

1. *Examination of the Placenta.* The value of diagnosis of syphilis from the placenta has lost much of its former importance. When a mother and child are syphilitic, one would expect a placental infection. However, placental lues is uncommon. McCord diagnosed only forty-eight syphilitic placentas from 1,085 strongly positive luetic women. The late J. Whitridge Williams diagnosed the infection in 12.1 per cent of infants who were eventually non-syphilitic, and failed to diagnose the placental lesion in 20 per cent of children who were congenital syphilitics. Warthin believed that the spirochæta was more numerous in placentas of macerated fetuses than in those of syphilitic living children. A review of charts of luetic and non-luetic patients delivered on the same day at The Long Island College Hospital suggests that the difference in relative weights of the placenta to that of the baby is not reliable to help in the diagnosis of syphilis. Today, a pathologist hesitates to commit himself definitely unless the spirochæta is found.

2. *The Cord Wassermann Is Not Reliable.* A child with a positive cord serology may eventually be free of syphilis, and a newborn with a negative cord serology may eventually develop evidence of the infection. The positive cord serology may be the reagin of the mother passing the placental filter and not the true serology of the child. The maternal and cord blood should be taken at the same time and titers of their reagin compared. A strongly positive maternal serology and a negative or weakly positive one in the cord blood should give a brighter outlook, as the arsenical seems to be more spirochæticidal in the fetal than in maternal tissue.

3. *Dark field examination of the scrapings of the umbilical vein wall,* in a section taken near the placenta, offers promise. Ingraham found the spirochæta in nineteen out of twenty cases, but in sixteen syphilitic infants, the scrapings were negative. If the spirochæta is found, the diagnosis is proved. If, however, the organism is not seen, it should not be interpreted to mean that the child may not eventually develop the infection.

4. *Roentgen examination of the long bones* about the eighth day is probably the most reliable method of diagnosing congenital syphilis. Wegner described the pathology thirty-five years before Schaudinn discovered the spirochæta. McCord found osteochondritis in 51 per cent of 243 syphilitic fetuses at autopsy. McLean believed that the lesion is present practically always in congenital luetic children. *X*-ray diagnosis has been made of a syphilitic child in utero.

The pathology, an osteochondritis, takes place at the union of the epiphysis and diaphysis of the long bones—at Guérin's line. Normally, the line is straight and narrow, but in syphilis it is widened, wavy and opaque. Heavy metal deposits during prenatal treatment may confuse the picture.

5. *Pediatric Follow-up.* A child born of a syphilitic mother does best under the care of a pediatrician trained in syphilis therapy. The serology of the newborn is no more reliable than that of the cord. Repeated blood tests about four weeks following delivery should be done. If positive at this time, the child probably has the infection, and treatment is indicated. If negative, however, a repeated blood test is done every month for four months, and then every six months, until the child has reached the age of two.

SUMMARY

1. The researches of Schaudinn, Wassermann and Ehrlich should have accomplished much in preventing and treating syphilis in the pregnant woman.

2. Physical examination often fails to suggest syphilis in pregnancy.

3. Alteration of the covering of the chorionic villi, which takes place in the middle of pregnancy, may be responsible for the loss of protection during late pregnancy.

4. Spirochætal infection does not cause an early abortion.

5. Since syphilis, in practically all pregnant women, is masked or in the latent stage, the diagnosis must be made by a routine serological test.

6. Repeated late abortions, premature or full term stillbirths should arouse suspicion of syphilis.

7. Complement-fixation and flocculation tests should be done.

8. Provocative injection of 0.3 Gm. of arsphenamine may reactivate the reagin of the serum.

9. Injection of arsphenamine in non-syphilitic women does not cause a positive serology.

10. Spirochætae have been found in abortions and babies of women whose serology was negative to the Wassermann test.

11. Blood transfused from a luetic donor does not necessarily transmit syphilis.

12. Treatment is instituted primarily in the interest of the child. The maternal syphilis is secondary.

13. Arsphenamine is found in the fetus late in pregnancy; the placenta serves as a reservoir.

14. It is in the interest of the child to treat the mother in each pregnancy.

15. Pregnant women are subject to encephalitis more often than non-pregnant women.

16. Examination of the placenta for syphilis has lost much of its importance.

17. The cord Wassermann is not reliable.

18. Dark field scrapings from the umbilical vein wall offers promise.

19. Roentgen examination of the long bones is very valuable.

20. Pediatric follow-up of children born of luetic women is imperative.

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EPIDURAL INJECTION THERAPY FOR SCIATIC PAIN*

HAROLD KELMAN, M.D.
Acting Assistant Surgeon, U. S. Marine Hospital
STAPLETON, NEW YORK

EPIDURAL injections have been used therapeutically for the past seven years in 116 cases. The conditions treated were sciatic neuropathy, sciatic neuritis, sciatic neuralgia, back pain, back injury with sciatic radiation, and lumbar and lumbosacral radiculopathy. (Table 1.) Relief of pain was the objective, although in a few cases soreness, painful numbness, muscle cramps, severe aching and burning were the main therapeutic indications.

TABLE 1

Diagnoses	No. of Cases
Neuropathy, sciatic, etiology undetermined	63
Neuropathy, sciatic, traumatic	7
Neuropathy, sciatic, traumatic (back injury)	8
Radiculopathy, lumbar and lumbosacral, etiology undetermined	7
Radiculopathy, lumbar and lumbosacral, traumatic (back injury)	5
Neuralgia, sciatic, etiology undetermined	5
Neuralgia, sciatic, traumatic (back injury)	8
Neuralgia, sciatic, psychogenic factor	4
Back pain	2
Neuritis, sciatic, infectious	7

The diagnosis of sciatic neuropathy or neuritis was made when the signs and symptoms were limited to that nerve distribution. The condition was designated as traumatic when verified trauma had occurred to the formed nerve at any point distal to its origin from the lumbosacral plexus. The diagnosis of neuritis was made only where there was a clear connection between the nerve involvement and an acute or chronic infection. The source might be an acute systemic infection, syphilis, obvious sinusitis, prostatitis or abscessed teeth. When symptoms were manifested in the sciatic distribution but no signs, the diagnosis of neuralgia was made. If back pain was present with or without previous back injury or with signs and/or symptoms in the sciatic distribution, the requisite diagnosis was made as defined above.

When the signs and symptoms were manifested in a radicular distribution the diagnosis of radiculopathy was made with the cause of the disorder added when known. There were no cases of radiculalgia or radiculitis in this series.

If the psychogenic factor was outstanding and no other cause was found for the disorder, it was so listed. Even though not indicated in the tabulation, the psychogenic factor was prominent in a number of the other cases treated by epidural therapy or other means.

In view of the above definitions it becomes clear why the preponderance of cases were diagnosed as sciatic neuropathy of undetermined etiology.

The technic of the treatment was carried out in the following manner: The patient is placed face down on a stretcher, which is maintained in fixed position. A pillow is placed under the hips to elevate the pelvis. (Fig. 1.) The procedure can be carried out two to three hours after a meal and usually without sedative preparation. In about 5 per cent of cases sedative preparation was necessary because of the patient's apprehension and excessive reaction to pain.

The area sterilized extends from just above the rectum to about six inches above the sacral hiatus and six inches to either side of the midline. The skin is antiseptically prepared by one application of tincture of iodine, immediately removed with 70 per cent alcohol. Draining of the iodine or alcohol down about the rectum or scrotum must be prevented. In six cases

* From the Division of Neurology and Psychiatry. Approved for publication by the Surgeon General, U. S. Public Health Service.

in which the iodine was not immediately removed, severe iodine burns occurred. Four of these patients had other skin

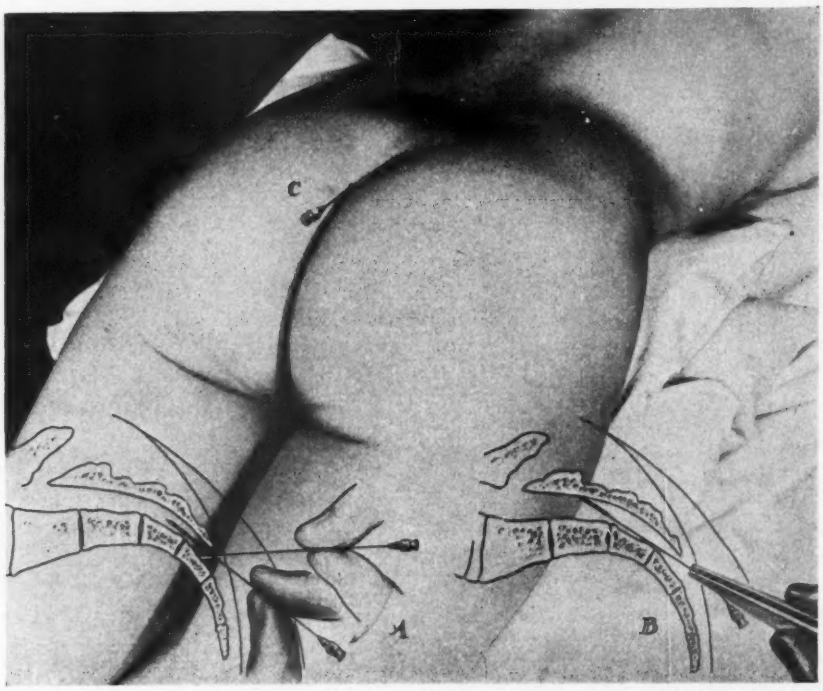


Fig. 1. Inserts A and B illustrate correct technic of inserting needle into caudal canal. Needle in caudal canal indicated by C. Correct position of patient, face downward and hips elevated is shown. (Illustrations courtesy of Dr. Geo. P. Pitkin from "Conduction Anesthesia," in preparation.)

idiosyncrasies. Antiseptics may be varied according to individual preferences.

The sacral hiatus can be located by palpation with the index finger or thumb upward from the tip of the coccyx and downward over the midline of the sacrum. The hiatus is identified when the palpating finger rests in a depression in which it can be rocked between two bony prominences, the sacral cornua. Usually it is present one and one-half to two inches above the coccygeal tip. However, anomalies are common. Often there are several dorsal apertures in the sacrum which may be entered for satisfactory further passage of the needle into the caudal canal.

The skin over the hiatus is infiltrated with ¾ per cent metycaine through a short beveled No. 23 gauge one-inch hypodermic needle. The subcutaneous tissues and the sacral canal are infiltrated with 5 cc. of ¾ per cent metycaine solution through a short beveled No. 22 gauge two-inch needle. The fluid injected into the sacral canal is introduced through a short beveled No. 20 gauge three and one-half-inch needle with a metal bead security stop. Only in one instance was the needle broken. That time the break was proximal to the bead, which afforded a purchase for withdrawing the needle.

In the last five cases, half the epidural injections in each case were done without preliminary anesthetization of the skin, subcutaneous tissues and caudal canal. The three and one-half-inch No. 20 gauge injection needle with metal bead security stop was immediately inserted into the caudal canal.

These patients stated that the procedure was no more painful when the preliminary anesthetization was dispensed with. If patients continue to report no preference, this latter technic will be adopted.

From the viewpoint of the experienced operator this technic has distinct advantages. Skin and subcutaneous tissue

infiltration more or less obliterate the landmarks and make the procedure more difficult.

Fig. 2. Sana-Lok Pitkin improved 5 cc. continuous flow syringe with side tubing attached and weighted filter.

The preferred injection apparatus is the Sana-Lok Pitkin Improved 5 cc. syringe (B.D.P5SLI). (Fig. 2.) It has a glass barrel and a metal plunger which contains a spring return permitting long continued filling and emptying without having to remove the needle from the skin or disengaging the needle from the syringe. The spring return and rings for the fingers and thumb shorten the time of injection and prevent operator fatigue. The flow is controlled by a positive action valve on the side of the piston head just below the thumb ring. The syringe can be used for a single injection by unscrewing the side outlet and screwing in a plug. Attached to the side outlet is eighteen inches of non-collapsible rubber tubing having at the end a sinker containing a screen to filter the solution.

The solution to be injected is placed in a glass tumbler. Both the syringe and the sinker are placed in the solution. The syringe is filled and emptied several times to clear the system of air. The connecting tubing permits continuous injection. (Fig. 3.)

In diminishing order of preference for injecting are the 10 cc. Luer-Lok syringe with ears and metal plunger, the 20 cc. all glass eccentrically placed tip syringe, the 20 cc. centrally placed tip syringe and lastly, the 50 cc. all glass centrally placed tip syringe. All the above syringes have been used at one time or another and given up for our present choice. They are mentioned because they are quite adequate when the other syringes are not available.

Traction is put on the plunger to ascertain the presence of bleeding which is a contraindication to continuing with the injection. The most common sources of the bleeding are from the traumatized structures of the sacral canal caused by the passage and scraping of the epidural needle. The injected fluid may seep into the vascular system through these traumatized areas. Rarely is a large enough blood vessel born to allow for the direct introduction of the needle.

On seven occasions it was believed that a passage had been forced through the dura and pia arachnoid into the subarachnoid space and cerebrospinal fluid returned. Rarely, when the subarachnoid space extends below the first sacral segment, may the needle be directly introduced into that space. The procedure should be interrupted following such an occurrence.

Frequently instead of entering the canal, the needle glides along the top of the sacrum. When the fluid is injected a swelling of increasing size is immediately seen developing over either side of the sacrum and lower lumbar area, or on both sides. The unilateral swelling is due to the deviation of the needle to either

side of the midline. When the needle is centrally placed the swelling is diffuse over the whole sacrum. There is seldom

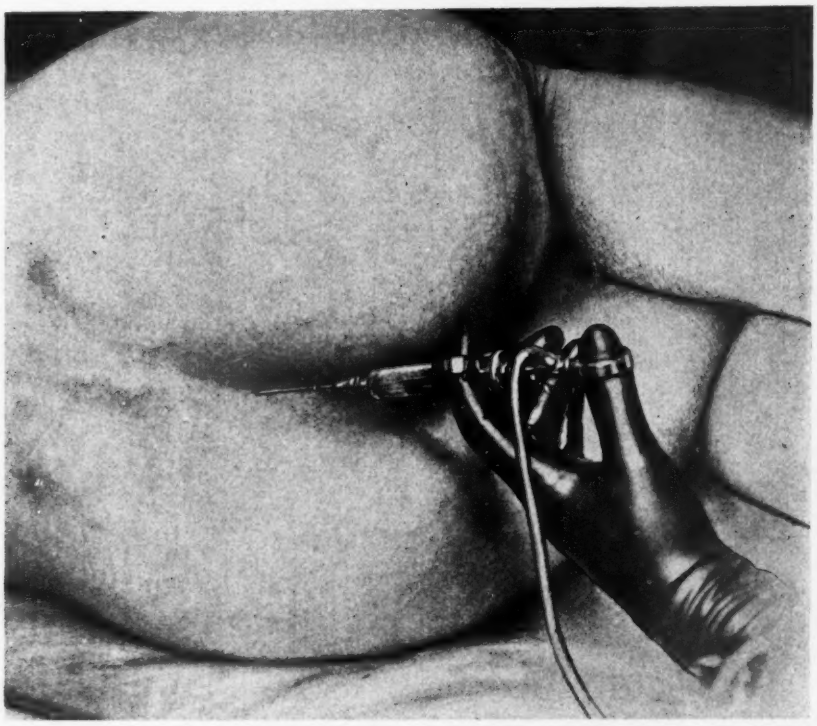


Fig. 3. Technic of caudal injection. Continuous flow syringe is shown attached to needle. Side tubing goes to reservoir of solution.

any associated pain and only a sensation of tension or tightness. No untoward effects following such malposition of the needle have been noted.

For the first four years normal saline was the injected fluid. Novocaine (1 per cent) in normal saline was used for the next two years. Metycaine (¾ per cent) in normal saline has been the solution of choice for the past year. These anesthetic agents have been added to allay the pain associated with the injection. At times the pain is quite severe. Also the anesthetic effect is an adjuvant to treatment. The vicious cycle of pain and muscle spasm is broken with resultant greater relaxation and longer periods of freedom from pain. These periods of relief give exhausted patients a chance for needed rest and sleep. It reassures them and gives them cause for optimism which attitude is conducive to improvement.

The period and degree of improvement following an injection are often beyond what could be objectively expected, unless we assume that the injection in addition to removing a primary cause of the sciatic pain such as peridural adhesions, and a secondary cause, pain due to spasm, also had a positive psychotherapeutic effect. It is believed that the result obtained is due to the above factors plus a number of other causes which are as yet not clear. The peridural adhesions which may be severed are most likely present about the nerve roots close to their entrance into the intervertebral canal. Adhesions about nerves are known to cause edema through the obstruction of free fluid flow in the nerve by cutting off the intrinsic blood and lymph circulation of the nerve and causing direct damage to the nerve by compression. This is particularly true in the rigidly or semi-rigidly contained spaces formed by the firm investiture of nerves by sheaths and dura.

Before ¾ per cent metycaine was used 1½ per cent metycaine was tried on three

patients. All three had mild shock reactions. The third manifested in addition a panic reaction as the anesthesia extended up to the nipple line. After the injection of ¾ per cent metycaine the anesthesia may be complete from the umbilicus down, although usually it is limited to the legs. Even with ¾ per cent metycaine, mild shock may occur but this is mainly due to several other factors.

When normal saline alone was used and injected with a 50 cc. syringe, three patients went into moderate shock and six more had mild shock. It was believed that this was due to the reaction to pain caused by the rapid introduction of the fluid, the acute exaggeration of the sciatic pain due to the sudden freeing of adhesions in and about the epidural space, and by the compressing effect of the injected fluid on the subarachnoid space and hence on the spinal cord and nerve roots. Another cause for shock, as well as headache, is the sudden distention of the epidural space acutely compressing the subarachnoid space and elevating the spinal fluid pressure. This sudden increase in spinal fluid pressure has been checked by the simultaneous placement of spinal and cisternal needles at the time of the epidural injection.

Also rents in the dura and pia arachnoid may occur after the initial check and form a passage into the subarachnoid space. It is, therefore, necessary to recheck during the procedure by frequent traction on the plunger of the syringe to determine whether a passage has been made into the subarachnoid space. This can be verified by the presence of cerebrospinal fluid in the aspirating syringe. Metycaine in varying amounts might thus reach the subarachnoid space and be another shock causing factor and also explain the extensive anesthesia up to the umbilicus and in one case up to the nipple line.

The whole procedure should not take more than thirty minutes, eight to twelve minutes being required for the actual injection. The injections are given three times weekly on alternate days. The same number of injections over a longer period are much less effective. Consecutive daily injections are beyond the patient's tolerance. The amount of fluid injected may be as little as 50 cc. although in most cases 100 cc. is injected. The interruption of the injections, at lesser injected amounts, is determined by the patient's reaction to pain and his mental response. The number of injections is usually between four and six, although up to eleven have been given and as few as three, with good results. Less then three were given because the patient interrupted the treatment or the reaction was so extreme that it was deemed advisable to stop.

Epidural injection was our treatment of first choice. The only adjuvant treatment was a bed board under a firm mattress and sedation. Many patients had been treated before or after with diathermy, fever therapy, high vitamin diets and parenteral vitamins, Buck's extension, prolonged bed rest, full body casts, orthopedic manipulations and a host of other measures. Many had been investigated for space displacing lesions impinging on the spinal canal and for a number of other possible conditions.

Injection therapy is the simplest, least expensive of all the therapies and fraught with the least dangers. The results of therapy can be determined in a short time.

The patient should be at rest horizontally for at least one hour thereafter because of the occasionally delayed shock reactions or the development of an extensive anesthesia. The reassurance of the physician that these late manifestations are not causes for concern is usually sufficient to ally the patient's apprehensions. If this previous reassurance were not given, the disturbance would be quite marked with hospital patients but even more disturbing to out-patients in whom these reactions occurred on their way home or at home. On two occasions anesthesia lasted twenty-four hours, and on six others up to four hours. Usually the anesthetic effect disappears in one to two hours. Only two

patients were treated as out-patients and these after they had been started on treatment in the hospital. Epidural therapy could easily be carried on as an out-patient procedure entirely or to shorten hospital stay once the treatment has been initiated.

Results have been found to be better if during the injection there is an acute exacerbation of the whole symptom picture and exceeding it in severity, particularly of the pain radiating down the involved leg. The relief may last from three to six hours and frequently for twenty-four hours. Often the pain will radiate down the opposite leg or up the back or down both legs and up both sides of the lumbar spine. The best results follow when the pain is sharp, lancinating and extends to the heel, and also when the relief is significant after the initial or first few injections. Often the pain felt in the hip during the first injection gradually extends down the leg with succeeding injections. Shortly thereafter the pain starts leaving the area about the sciatic notch, then the posterior aspect of the thigh and upper leg and disappears last from the foot.

The relief obtained after the acute effects of the injections have passed often follow this sequence. The severity of the pain abates. The defensive flexion at the hip and the knees, as well as the associated sciatic scoliosis, become less marked. The patient can now sleep without the terror of being awakened by an exacerbation of pain due to getting into the "wrong position." The associated spasm of the erector spinae muscles, as well as the tilt of the pelvis, becomes less marked. Pressure tenderness along the course of the sciatic nerve diminishes. The patient can begin to straighten up and walk erect with less of a limp. The range of flexion at the hip of the extended leg increases. Numbness along the posterior aspect of the leg disappears. Even such extensive sensory loss as to involve L 3, 4, 5, and S 1 and 2 dermatomes have disappeared. The coldness and cyanosis commonly present and involving the foot and lower leg becomes much less marked. The pain first leaves the areas close to the sciatic notch and moves distally so that the patients often say "the pain is moving out of my leg right through my toes." It is only after the above sequence has occurred that the patient can actually realize how much weakness there is due to disuse and actual nerve involvement. Although much tonus and power returns rapidly, it may take months of graduated exercises to bring the involved leg back to an approximate normal. Only persistent efforts on the part of the patient can lead to the complete recovery of muscle power and muscle mass.

The results obtained are classified as cured and improved, markedly, moderately, slightly and none. (Table II.) No correlation is attempted between the severity of the symptoms and the results. The initial relief may be quite dramatic in severe cases but the end result may vary as with the milder cases. Cure only refers to the symptoms of the present attack and not to the signs which take a variable period to disappear. When all the symptoms have entirely disappeared the result is considered as a cure. This explains the small number in this category and the much larger numbers in the categories of marked and moderate improvement.

TABLE II

Result	No. of Cases
Cure	8
Marked improvement	41
Moderate improvement	45
Slight improvement	17
No improvement	5

Another factor in the low percentage of cures and good results is the patient's desire to get back to work as soon as possible or at the first signs of relative comfort. Also the results were tabulated on the basis of the condition on discharge. Since many of these patients would return or would be returned to this hospital if they had a recurrence, it may be assumed that further improvement took place and that a careful follow-up study would improve our statistics. Follow-up on a small number of our patients verified this supposition.

If there is still even some slight occasional pain, soreness, aching, coldness or numbness of the foot, the result is classified as markedly improved. When any of the above are still present to a moderate degree, the result is classified as moderately improved. Patients with marked and moderate improvement can and do return to their previous occupations, often of a strenuous variety. These patients first start at light duty and resume regular duty in one to two months. Patients with only slight alleviation of symptoms cannot return to work. As the tabulation indicates most patients obtain some degree of relief and only a few get none at all. In such cases one form of treatment after another is instituted. These treatments have been listed above. The complexity of the problem is clearly demonstrated by the fact that even after all our efforts, too many patients remain incapacitated, have no relief or are left with some symptoms and signs or have recurrences.

Failures or poor results were frequent when significant psychologic problems were present. Most of these cases had erector spinae spasm, scoliosis and sciatic pain and were diagnosed as sciatic neuralgia. The low percentage of any improvement following epidural injections in cases in which there is a large functional element, belies the value of such a measure as a therapeutic aid. Careful follow-up studies of patients treated by physical or medical means for physically manifested psychologic disorders have revealed similar poor results. There is transient improvement of variable duration with remission or with the substitution of a new set of physical or mental symptoms. The treatment of psychologic disorders is psychotherapy.

In 294 cases one or two epidural injections were given for diagnostic and/or therapeutic purposes with almost dramatic relief in sixty-nine cases and a variable degree of relief in the remaining number. These positive results might be considered valid in about half the cases. However, it was believed that patients receiving less then three injections should be excluded from the series. Too many factors could account for such dramatic results after only one or two injections. These factors are partially organic but essentially psychological. One factor is the extreme suggestibility of certain patients. Some patients feared the pain of the injection or "needles" so much they refused the treatment altogether or stated they were entirely relieved of pain after one or two injections. Further observation of these patients revealed that many of them still had symptoms and signs.

Whether the causes for the pain have been removed is difficult to verify. A cure is no assurance that recurrence will not occur. In fact they are quite common. There were three recurrences in our own previously "cured" patients who had been completely relieved through treatment. The result of treatment with the second series of epidurals was not as good as on the first occasion. Results are better when the first attack is treated than with recurrences. By the time a second or subsequent attack has occurred irreparable nerve damage has occurred, as well as extensive fibrosis in the muscles.

During the same seven-year period as this series ran, 63,452 cases were admitted to the hospital for all causes. It may be estimated that for every patient treated for the complaint of sciatic pain on the service of neurology and psychiatry there are five others treated on all other services. During this period the total number of cases treated by the service of neurology and psychiatry was 5,783. The number of cases treated for the complaint of sciatic pain as part or all of their symptom picture was 410. Twenty-seven per cent of these cases were treated by epidural injections. Patients with sciatic pain treated on that service would make up 0.07 per cent of the total admissions. An estimated percentage for the whole hospital would be 0.04.

In 294 cases a simultaneous epidural injection and lumbar puncture was performed as part of the investigation for

herniated nucleus pulposus. A pneumorachiography was performed in 126 of these cases and only two herniated discs were found.

A total of 526 epidural injections was given in the series, an average of about 5 per patient. In the cases receiving less than three a total of 466 injections were given making an overall total of 992 epidurals in seven years. These epidurals were administered by twelve different operators.

The preponderance of males in this series is in large measure due to existing laws relating to eligibility for treatment by the U. S. Public Health Service. There were only five women in the series.

TABLE III

Decade	No. of Cases
10–20	1
20–30	15
30–40	34
40–50	49
50–60	13
60–70	4

The concentration of cases in the third and fourth decades (Table III) may be due to years of strenuous physical labor, multiple back traumas and the aging process. Heavily muscled men seemed more prone to sciatic symptoms and sequelae from back injuries. The youngest patient was nineteen and the oldest sixty-seven. There were fewer patients in the older age group because many of our beneficiaries have with increasing years of service and through advancement some less strenuous type of occupation.

In sixty-two cases the right side was affected and in forty-eight cases the left. There was bilateral involvement in five cases. In eleven cases the second attack was treated and in two cases it was the third. In one case it was the fifth attack and in another the seventh.

SUMMARY

In seven years 486 epidural injections have been given to 116 patients with the complaint of sciatic pain.

The favorable results warrant the selection of this form of treatment for a fair and early trial.

A cure resulted in eight cases, marked improvement in forty-one, moderate in forty-five, slight in seventeen, and no improvement in five cases.

TRAUMA OF THE THORAX*

COLLECTIVE REVIEW

HENRY H. RITTER, M.D. AND B. BERNARD KAYE, M.D.
NEW YORK, NEW YORK

THE modern industrial era plus the present military conflict has increased the incidence of all injuries. The use of bursting bombs, artillery and machine gun fire, accompanied by falling masonry, has caused a high percentage of immediate fatal chest wounds.

This paper is a review of thoracic trauma varying from a simple contusion to a marked compression; from a superficial laceration to a through-and-through perforation.

In thoracic trauma the symptoms of greatest importance are dyspnea and cyanosis. Butler[22] contends that a certain degree of shock is desirable in these cases as the hemorrhage from the injured soft parts often subsides and remains controlled unless too active therapy is instituted.

The first aid treatment[47] of thoracic injuries must deal with the urgent condition of (1) shock and hemorrhage, (2) the altered intrathoracic physiology and dynamics. First aid treatment should minimize any additional contamination and help make the patient safer for thoracic surgery.

The disturbed intrathoracic dynamics may in itself be the chief cause of shock, and it may be impossible to combat shock until the heart and lungs have been put in working order. Unlike injuries to less vital parts local treatment may take precedence over general treatment. Sudden pressure changes must be corrected in the shortest possible time with the least possible surgical trauma.

An extensive crushing injury can occur within the thoracic cavity but with little damage to the chest wall. Trauma may involve the pleura and lungs singly or in combination.

Trauma requiring immediate intervention are wounds of the heart and esophagus, hemorrhage from an intercostal, internal mammary or pulmonary vessel, compound fractures, tension or open pneumothorax and mediastinal emphysema. These emergencies usually arise as a result of a penetrating trauma. Cardiac and esophageal trauma has been omitted in this paper and is to be treated in a later publication.

In discussing the treatment of the various forms of chest injuries, a number of classifications have been suggested; however, these are unsatisfactory because of the multiplicity of these lesions and their complications.[2,11,12,13,18,42,72,110,131] For simplicity the types and treatment of the various thoracic trauma are considered under separate headings. It must not be assumed that these lesions are the only injury sustained; there may be injuries to other parts of the body.

ANATOMY AND PHYSIOLOGY

The lungs lie free within the corresponding pleural cavity and are attached only by their root and the ligamentum pulmonale.[33] The apex of the lung rises above the level of the oblique first costal arch to the full height of the cupula pleurae. It protrudes through the superior aperture of the thorax into the root of the neck for a distance of one to two inches above the anterior extremity of the first rib. This may be of clinical importance in penetrating wounds of the supraclavicular area.

* From the Surgical Service, Reconstruction Hospital. Acknowledgment is made to Dr. Frank H. Netter for his helpful anatomical and physiological contributions.

The hilum is a wedged-shaped depression within which two pulmonary veins, the pulmonary artery and the bronchus, enter and leave the organ.

The diaphragm comes upward, infringing upon the long axis of the thorax, leaving at its periphery the deep costophrenic sinus, deeper behind than in front.

A cross section of the chest shows the vertebral column projecting forward into the cavity, so that the distance between the sternum and spine is relatively small, about four to four and one-half inches. In each side lies a large paravertebral gutter which accommodates much of the lung tissue. It is in these areas that fluid tends to accumulate in the pleural cavities and where aspiration or drainage will be most effective.[144]

The lungs are held out against the chest wall in a state of tension by the negative pressure in the pleural sacs, and these elastic organs pull like evenly balanced springs on each side of the mediastinum. In the body the lungs fill the pleural cavity completely, but constantly tend to collapse to their own normal size. The elastic recoil of the lungs creates a suction in the pleural space which results in a negative intrapleural pressure of 5 mm. of mercury. During growth, since the thorax enlarges at a slightly faster rate than the lungs, the tension on the latter and the resulting intrapleural vacuum increases.

SIMPLE FRACTURES

1. *Ribs* (Fig. 1). A direct injury to the chest wall may produce simple fractures of the ribs without involvement of the lung or its visceral covering, but it always involves the parietal pleura. The fracture may occur anywhere along the course of the rib, the cartilage or at the costochondral junction.

Compression of the thorax in the anteroposterior plane causes a lateral widening of the thorax; and if a fracture results, it is usually in front of the angle of the rib at a distance from the force. Muscle violence,[79] as a rule, breaks the rib anterior and sub-periosteally, the seventh to eleventh ribs being most frequently involved.

A single fracture is usually end-to-end; multiple fractures may overlap. The first two ribs are rarely injured, the sixth, seventh and eighth are most commonly fractured.

Diagnosis is easily made on the history of trauma to the thorax followed by persistent pain, shallow breathing, and inclination toward the affected side. Pain is aggravated by respiration, coughing, sneezing, etc. The degree of pain depends on the amount of injury to the ribs, as the lung and the visceral pleura are insensitive.[143] Roentgenograms in three planes will usually confirm the diagnosis.

Treatment. Treatment should be instituted regardless of the roentgenographic findings, as callus formation may make its appearance at a later date, in spite of previously reported negative *x*-ray plates.[140,167] It is impossible to immobilize the ribs completely, but nature by muscle spasm tends to immobilize the ribs partially, and proper strapping of the chest wall aids considerably. Absolute immobilization is not essential for proper union. The strapping should encircle at least two-thirds of the circumference of the chest, beginning and ending on the sound side. Blades[12] advocates partial immobilization of the entire thorax regardless of the level of the fracture with a single strip of adhesive which encircles the lower costal margin. Strapping reduces the tidal and vital capacity and lessens the effectiveness of the cough.

Latteri and Nicolosi, Italian surgeons, recommend alcoholization of the intercostal nerves to produce immobilization of the involved ribs.

The afferent painful stimuli can be interrupted at the site of fracture by means of local anesthesia. Procaine solution or a double solution containing 5 per cent procaine hydrochloride and 1 per cent eucupine dihydrochloride to which epinephrine hydrochloride is added may be used.[67,89]

Other methods recommended are binders, corsets and the "Sam Browne" plaster belt.[136,137,165,173]

2. Dislocations at the costovertebral joint are rare and are usually overlooked. This entity must always be borne in mind when a patient complains of pain encircling the chest at a definite level due to involvement of a nerve radicle. One or more ribs may be torn from their vertebral attachments as a result of direct violence. Immobilization by adhesive strapping is generally sufficient to alleviate the pain element.

3. Fracture and dislocation of the costal cartilages occur mostly in young adults. Costal cartilages are not visible on the roentgenogram unless they are calcified.[89] Diagnosis is based on the history and physical findings. Deformity or obvious dislocation may be present.

Treatment. Reduction of the dislocation is attempted by drawing the shoulders back and manipulating the displaced cartilage back into its normal anatomical position. This is supplemented by adhesive plaster immobilization.

4. Fractures of the sternum are usually caused by direct violence, often the result of an automobile accident when the driver's chest is forced against the steering wheel. The underlying mediastinal contents may be injured. The fracture is generally transverse and most frequently occurs near the junction of the manubrium and body of the sternum. The upper fragment is usually displaced posteriorly, and the extent of the deformity will depend upon the amount of displacement. Pain is intensified by sneezing, coughing, etc. Extensive *x*-ray study, particularly in the lateral plane, is essential.

Treatment. Reduction of this type of fracture is often difficult using the closed methods. Hyperextension of the neck and thorax plus manipulative reduction should be attempted before instrumental or operative procedures are used.[119] Corkscrew or hook traction may be helpful in some cases.[129]

COMPLICATED FRACTURES

1. A depressed fracture does not necessarily traumatize the underlying pulmonary tissues. When the depressed fragment does tear the underlying lung, it may result in a hemothorax, pneumothorax, subcutaneous emphysema or a combination of these pathological entities. (Figs. 2 and 3.)

Treatment. Treatment in these complicated injuries should be primarily the prevention and treatment of shock. Conservative measures should always be employed. The necessity for surgical intervention will depend upon the physical findings. Depressed fragments involving the pleuropulmonary structures may require elevation and repair of the damaged tissues.

2. Stove in chest injury[12] may follow direct violence to the chest wall.[129] It usually involves several ribs, at two points, along the course of the rib. The loose fragments become depressed during inspiration and bulge during expiration. This condition may or may not be associated with an underlying pulmonary pathological condition.

Treatment. Conservative treatment consists in strapping the chest wall to stabilize the parodoxical motion of the mobile thoracic wall. If conservative measures fail to relieve the respiratory embarrassment, elevation of the loose fragment should be undertaken. Elevation may be accomplished by means of perichondral wire suture, towel clips or open fixation.

3. Sternochondral fractures with depression of the sternum is generally accompanied by some injury to the underlying mediastinum and its contents. The depressed manubrium may interfere with the venous return in the superior mediastinum. Cardiac embarrassment must be relieved by elevation of the sternum; this may be accomplished by towel clips, screw traction or open fixation.[86]

4. Compound fractures of the ribs rarely occur without injury to the underlying

pleuropulmonary structures. When they do occur without such involvement, they are usually tangential as a result of nonpenetrating wounds caused by fragments of high explosive missiles and should be treated in the same manner as wounds of other parts of the body.[10] Thorough wound excision, removal of devitalized tissues, foreign bodies and bony splinters, implantation of local sulfa drugs[21,23,55,73,77,84,88,126] and closure of the skin by either primary suture or packing should be carried out. Care must be exercised not to enter the pleural cavity. When there is considerable loss of substance, the rib above and below may be drawn together by sutures placed around them.[14] Wounds over the posterior thoracic wall are more susceptible to infection due to the massive musculature of this area and the presence of fascial planes which permit extension of blood and infection.

The more common type of compound fracture of the rib involves the underlying pleuropulmonary structures. Thoracotomy is necessary to determine the possibility of lung injury by an indriven rib fragment or missile. In such cases exploration of the pleural cavity is carried out in addition to the above mentioned débridement. The pleural cavity is cleared of bloody fluid and accessible foreign bodies. The pulmonary wounds are débrided and wedge resection of the lung performed if necessary for the removal of devitalized tissues. Hemostatic suture of the lacerated lung with airtight closure of severed bronchi are effected. The wound is drained subcutaneously and the pleural cavity drained with a tube under water. Closed drainage for forty-eight to seventy-two hours is advisable following exploration with extensive débridement of the lung and pleural cavity. The evacuation of exudates will prevent infection and reduce pulmonary pressure.

Contusion. Contusion of the thorax with or without osseous involvement may result in a traumatic pleurisy. This usually subsides within seven to ten days, unless complications set in. Contusion may be followed by atelectasis, pneumonia or activation of a quiescent tuberculosis.[19] A number of observers have described so-called contusion or traumatic pneumonia.[124,139,152]

Treatment. Symptomatic strapping and sedation may be necessary to allay the pain.

Pulmonary Laceration. Lacerations of the lung are more commonly present in penetrating injuries, but may also be caused by indriven rib fragments penetrating the underlying lung. This often results in a hemothorax, pneumothorax or subcutaneous emphysema. Laceration of the lung is to be suspected if there is bloody expectoration and signs of a hemothorax. In some instances damage to the intrathoracic structure can occur in the absence of demonstrable evidence of thoracic wall lesions.

Treatment. Conservative treatment is to be followed unless active bleeding or signs of obstruction of the venous return to the heart are noted.

Graham[63] believes that environmental facilities, the presence of surgical equipment and adequate assistance should govern the decision between conservative and operative treatment.

Simple suture of the laceration and ligation of the bleeding vessel with reinflation of the lung will be sufficient to control the majority of penetrating wounds. Accurate identification of a bleeding point in lung parenchyma may be time consuming and difficult. In those cases the bleeding can be controlled by a continuous mattress suture into the lung substance.

Extensive pulmonary lacerations may require partial or complete lobectomy or even pneumonectomy. Bleeding from the lung may require application of a tourniquet to the root of the bleeding lobe to facilitate suturing of the laceration.[95] If difficulty is experienced in controlling hemorrhage from the lung parenchyma, the lung may be partially exteriorized and sutured under direct vision.[35] This has the added advantage of fixation of the lung

with consequent stabilization of the movable mediastinum. All pulmonary wounds should be completely closed. When an accumulation of air or blood is to be anticipated, closure with under water drainage as a safety measure is instituted.[115] Closed drainage prevents entrance of air into the pleural cavity but allows escape of fluid and air. This drainage is maintained about forty-eight hours.

Once an exploratory thoracotomy is decided upon, a Robert Nelson hilar tourniquet should be held in readiness for those patients requiring resection of a lobe or even an entire lung.[19]

HEMOTHORAX

Butler[22] maintains that a hemothorax (Fig. 4), in some degree, follows all chest injuries.

Hemorrhage is probably the most common finding in all injuries. In the thorax it may involve the vessels of the chest wall or more frequently the underlying lung parenchyma.[1] It may vary from a subpleural hemorrhage in simple contusions[37] to a massive fatal hemorrhage from the mediastinal or hilar vessels in severe injuries, involving an entire lobe or even both lungs.[141] Hemorrhage from the chest wall is usually caused by injuries to the intercostal, internal mammary and occasionally the azygos vessels. Arterial bleeding from the intercostal or internal mammary vessels occurs at a pressure six times as great as that of the pulmonary circulation, and thereby produces its signs and symptoms early.

Bleeding from the lung parenchyma is usually slow and involves the smaller pulmonary vessels. Hemorrhage from the large mediastinal or hilar vessels is generally severe and fatal.

The intercostal space is relatively safe as regards the risks of hemorrhage. The segmental vessels and nerves are under cover of the lower border of the corresponding rib.[144] The intercostal artery medial to the angle of the rib is approximately in the center of the intercostal space, and from that point anteriorly the vessel progressively approaches the inferior border of the rib above, so that from the angle of the rib forward the vessel is under the edge of the rib in the subcostal groove and simple circumcostal massive suture may be insufficient.[52] The presence of a hemothorax, without fracture of a rib, as a rule excludes the intercostal vessels as the source of hemorrhage. The intercostal vessels are more frequently injured in compound fractures than in depressed rib fractures.

The increase in intrapleural pressure causes a disturbance of the cardiorespiratory physiology. There is diminution in the vital capacity with increased resistance in the pulmonary circulation. The resultant pressure on the central mediastinum interferes with the venous return to the heart, thereby causing diminution in the cardiac output. Death may result from respiratory and circulatory failure.[45]

Clinical manifestations are pleural effusion with displacement of the mediastinum away from the affected side; this displacement may be absent if there is considerable pulmonary collapse beneath the effusion. Objective signs of fluid are found in the form of dullness on percussion, diminished voice and breath sounds, which vary with the size of the effusion.

In both open and closed wounds of the thorax a hemopneumothorax may ensue from the entrance of air through the chest wound or escape of air from the lacerated lung. Radiographic examination reveals a diffuse shadow extending from the base upward, and encroaching upon the normally translucent lung. There is an obliteration of the cardiophrenic or costophrenic angles. In a hemopneumothorax a definite fluid level can be seen in the radiograph. It is important to remember that hemothorax may develop many days after the original injury.[24]

Treatment. The source and severity of the hemorrhage in hemothorax is the determining factor as regards treatment. Because the falling blood-pressure and the

rising pressure in the pleural cavity tend to stop the hemorrhage, treatment should be expectant until either circulatory or respiratory signs and symptoms indicate change.[74]

Simple limited hemothorax can be treated expectantly.[4,96,44,46,71] A localized hemothorax without displacement of the apex beat can be left alone safely. Hemothorax produces a partial compression of the lung, which in turn arrests some of the hemorrhage.

Aspiration of blood should be avoided within the first forty-eight to seventy-two hours unless there are definite signs of cardiorespiratory distress. Aspiration can be performed in the seventh or eighth interspace in the midscapular line. Zenker[172] states that reaccumulation of fluid after aspiration is generally due to pleural irritation and not to recurrent bleeding. Aspiration of blood, followed by air replacement favors arrest of hemorrhage.[9,54,76,111,146] Recent articles, especially of British authors, favor this method of treatment.[38,51,82,91,98,104,125,130,132,158] This method is not attempted in hemothorax due to bleeding from the intercostal or internal mammary vessels. The aspirated blood from the pleural cavity provides an excellent culture medium,[43] and should be subjected to smear and culture study.[45] According to Foster[53] aspiration lessens the possibilities of adhesions and permits re-expansion of the lung and also enables visualization of foreign bodies by *x*-ray.

Thoracotomy is indicated for persistent bleeding from the vessels in the chest wall or pulmonary circulation. In open wounds, direct ligature or pericostal suture to the bleeding artery may be a lifesaving procedure. If the bleeding persists as evidenced by an increasing hemothorax, thoracotomy is indicated. This consists of wound excision, ligation of the bleeding vessels and wound closure without drainage when the pleuropulmonary structures are not involved. Hemorrhage from the internal mammary artery is to be suspected if there s a wound about 1 cm. lateral to the sternal border with escape of bright red blood from the wound and not from the tracheobronchial tree. Fatal hemorrhage from an intercostal vessel may occur unless surgical ligation is performed.[34] A bleeding internal mammary artery must be ligated above and below the opening because of the double source of blood supply to these vessels.[35] Active reaccumulation of blood in the pleural cavity following aspiration suggests active bleeding and provides an urgent indication for thoracotomy. Death may result from increased intrathoracic tension.[45]

PNEUMOTHORAX

A pneumothorax (Fig. 5) is an accumulation of air in the pleural cavity. It may be localized by adhesions, but more commonly air is distributed evenly throughout the entire pleural space. Pneumothorax may result from injury to the pleura with air entering the pleural cavity from without, or injury to the lung, bronchus or esophagus with air entering the pleural cavity from within. Occasionally, it may be caused by the tearing of pleural adhesions.

Symptoms of respiratory insufficiency, cardiac embarrassment and peripheral circulatory failure in the various types of pneumothorax depend upon the volume of lung that is collapsed, the rapidity of onset, the degree of mediastinal displacement and the initial vital capacity of the patient.[63] The objective signs are restricted motion of the affected side, hyperresonent percussion note, distant or absent breath sounds, and displacement of the apex beat and cardiac dullness to the contralateral side. *X*-ray reveals a structureless field in which lung details are absent. The outline of the ribs is sharply defined and the lung is collapsed toward the root. The trachea shows displacement to the opposite side.

Types—Closed. In this type the thoracic wall remains intact with air entering and leaving the pleural cavity during inspiration and expiration.

With the lung at rest, the intrapulmonic pressure is the same as that of the atmos-

Fig. 1—SIMPLE THORACIC CAGE INJURIES

Courtesy Ciba Pharmaceutical Products, Inc.

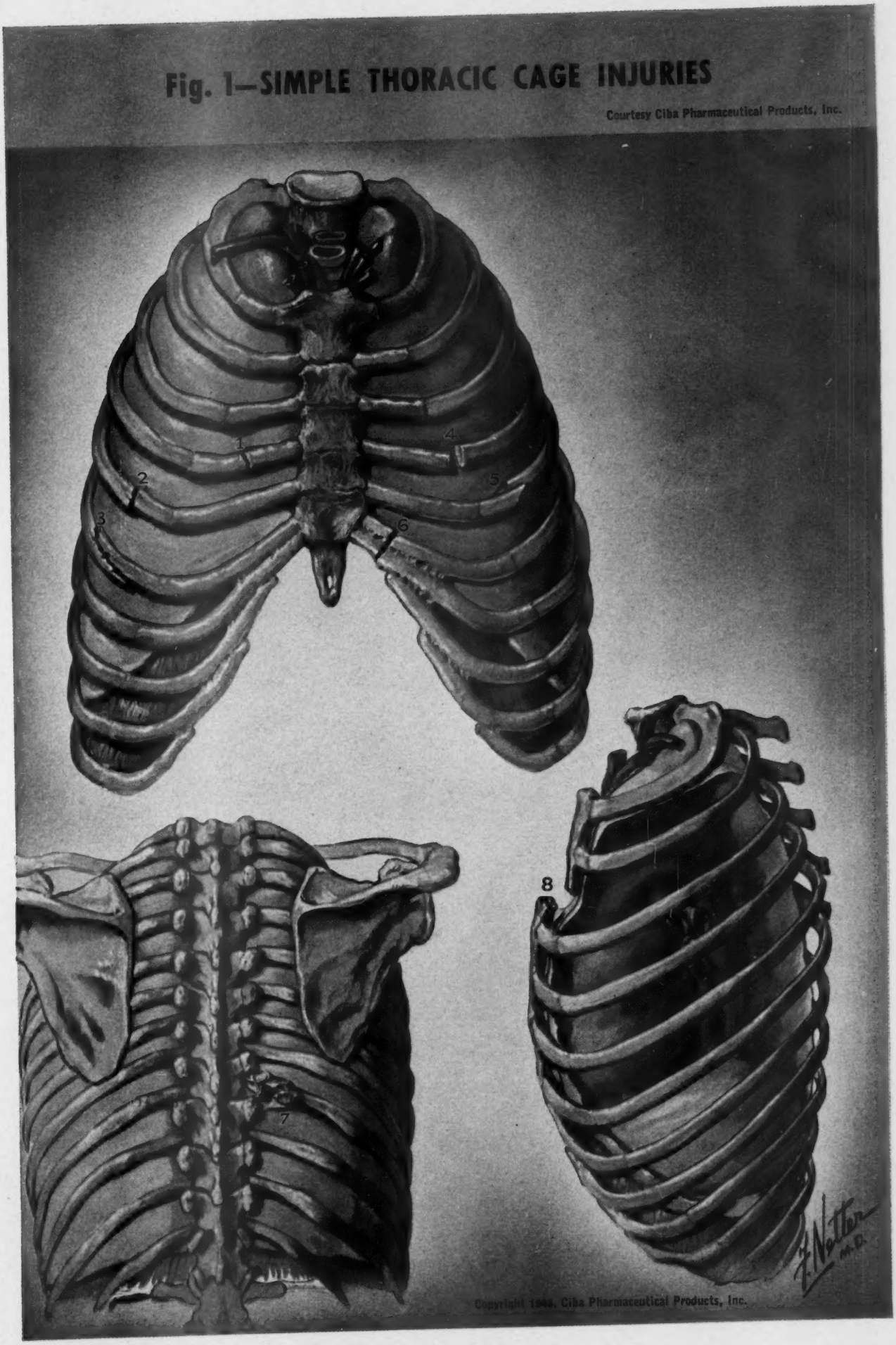


Fig. 2—COMPLICATED THORACIC CAGE INJURIES

Courtesy Ciba Pharmaceutical Products, Inc.

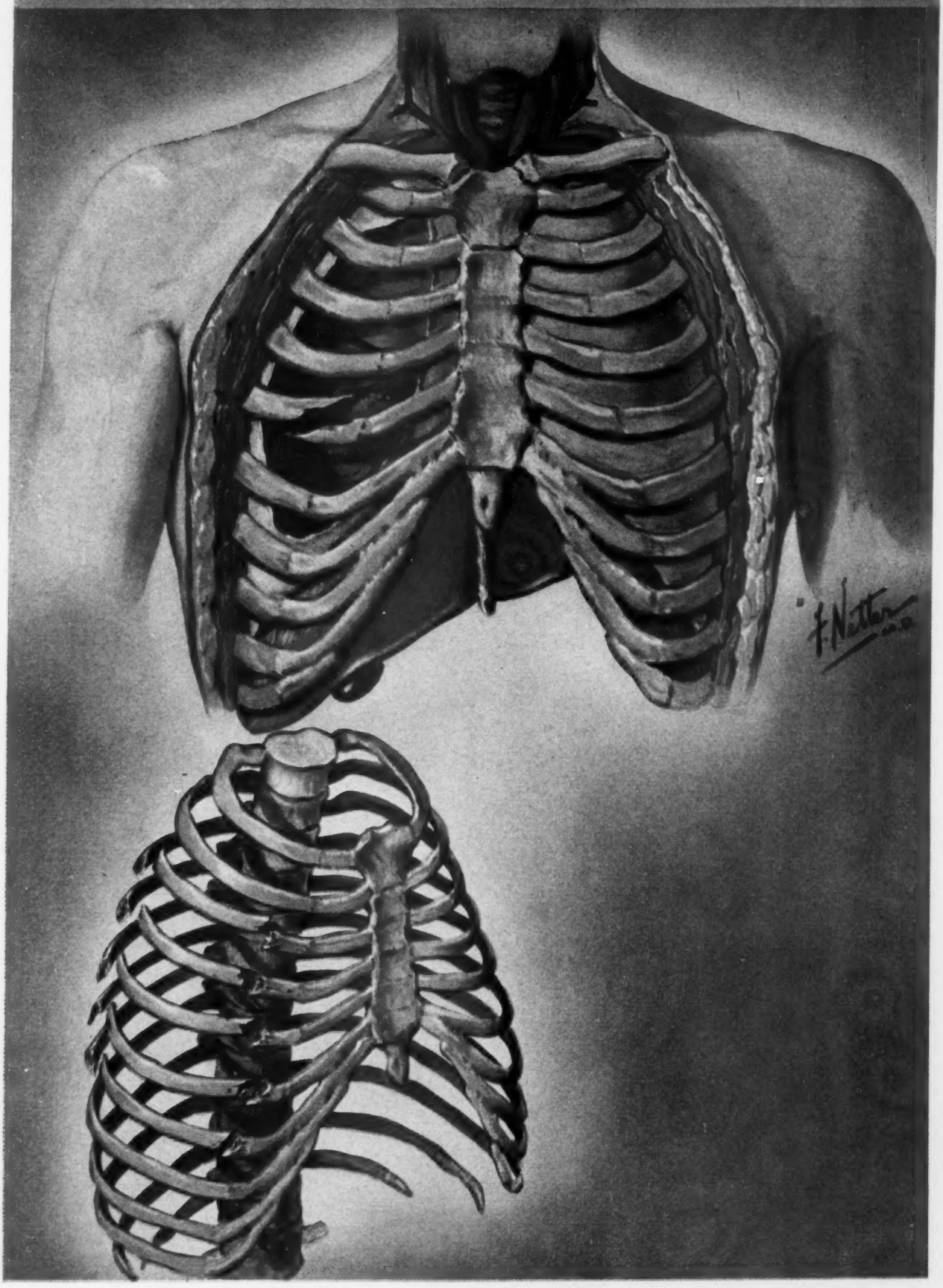


Fig. 3—COMPLICATED THORACIC CAGE INJURIES

(CONTINUED)

Courtesy Ciba Pharmaceutical Products, Inc.

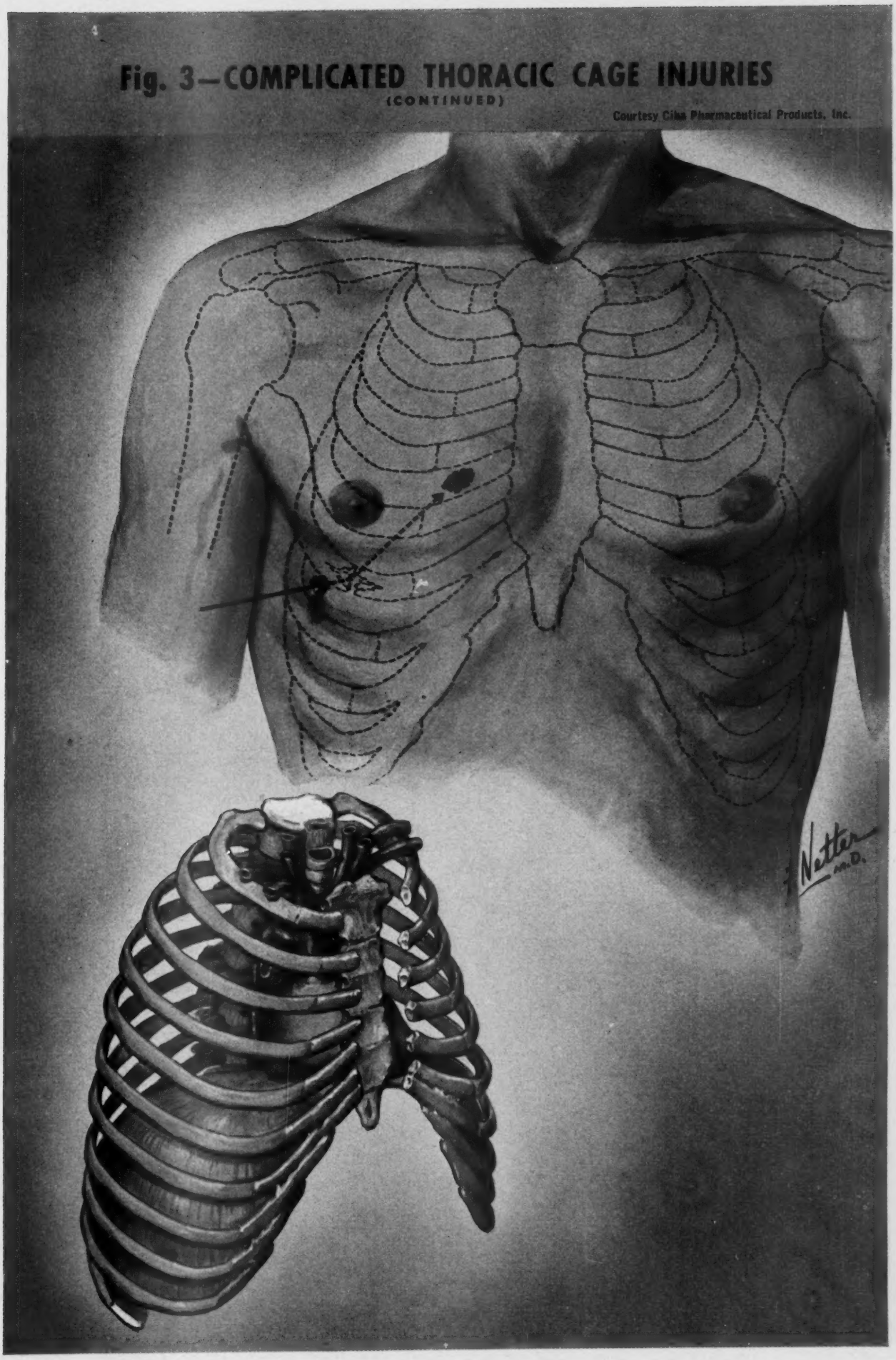


Fig. 4—HEMOTHORAX

Courtesy Ciba Pharmaceutical Products, Inc.

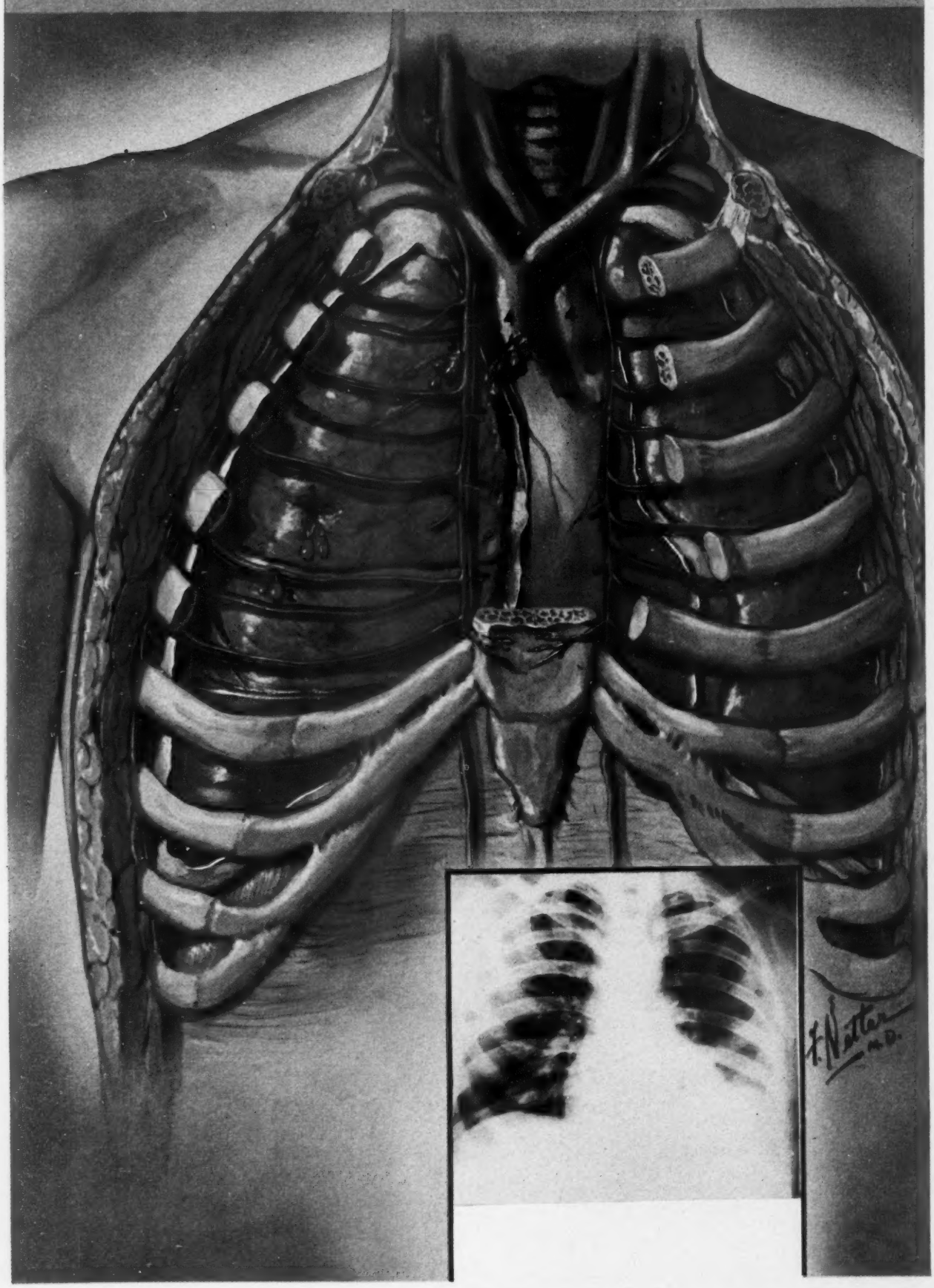


Fig. 5—PNEUMOTHORAX
CAUSES AND TYPES

Courtesy Ciba Pharmaceutical Products, Inc.

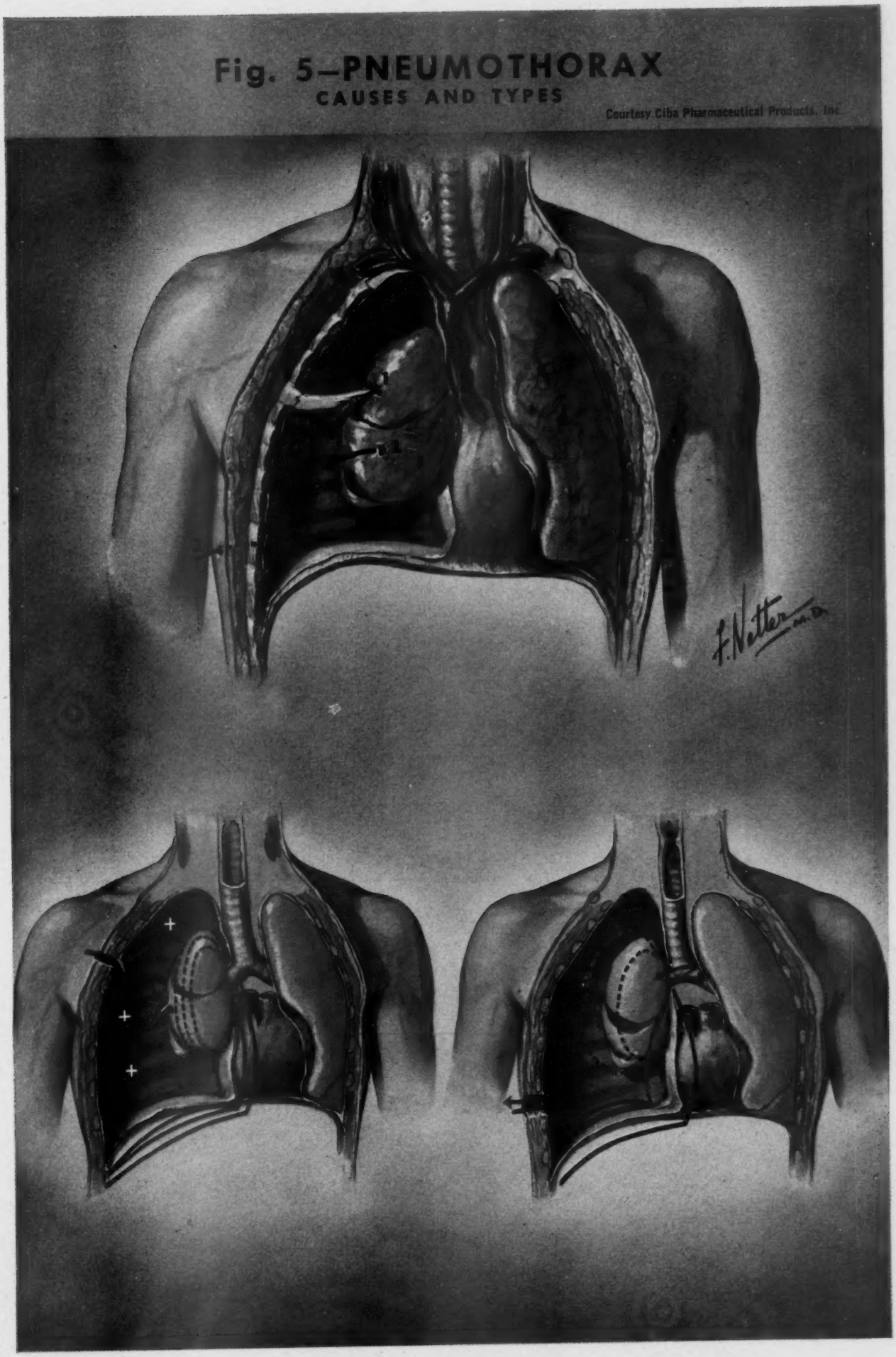


Fig. 6—EMERGENCY TREATMENT OF PNEUMOTHORAX

Courtesy Ciba Pharmaceutical Products, Inc.

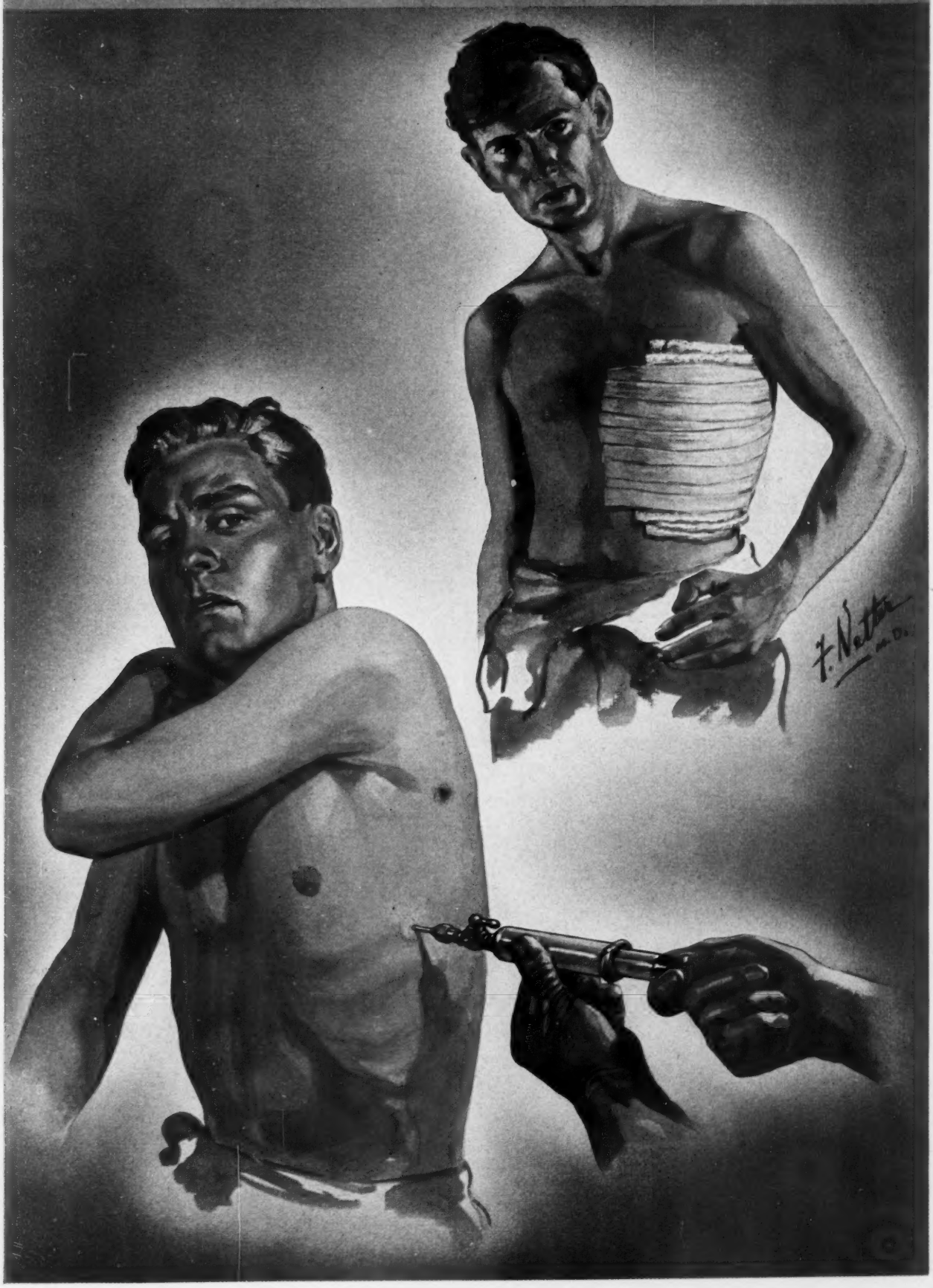


Fig. 7—EMPHYSEMA

Courtesy Ciba Pharmaceutical Products, Inc.

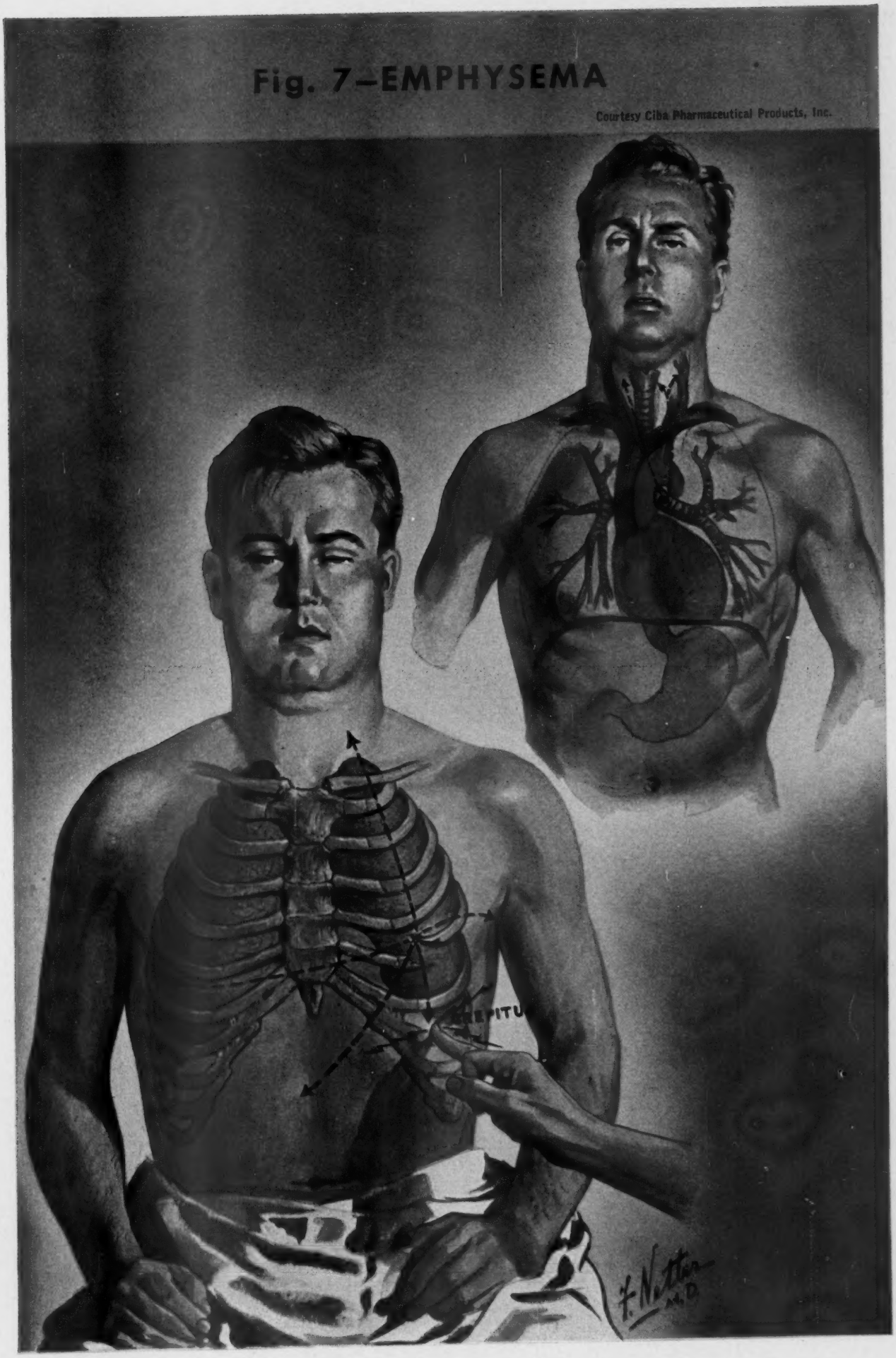


Fig. 8—MASSIVE COLLAPSE (ATELECTASIS)

Courtesy Ciba Pharmaceutical Products, Inc.

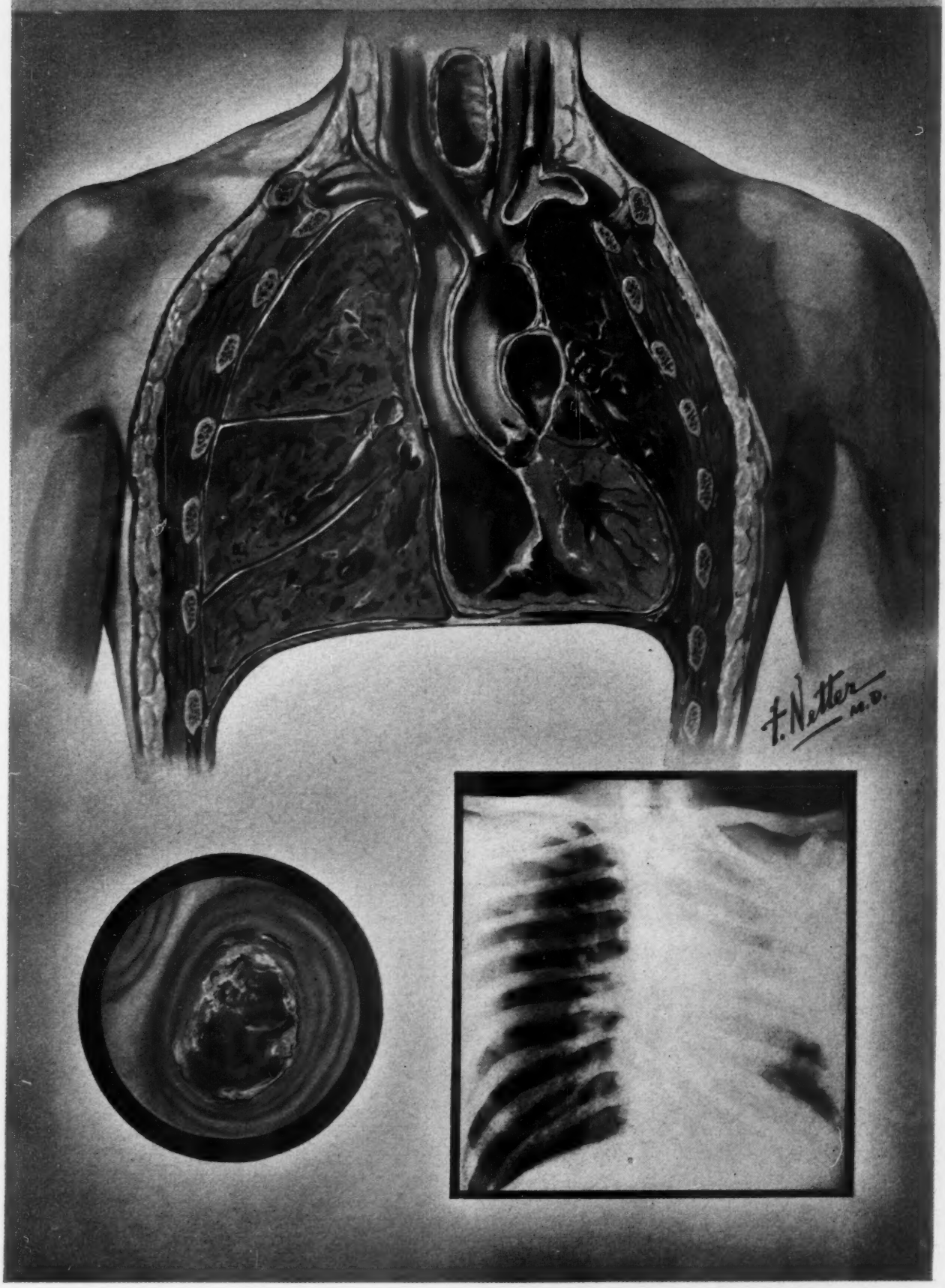


Fig. 9—TRAUMATIC ASPHYXIA

Courtesy Ciba Pharmaceutical Products, Inc.

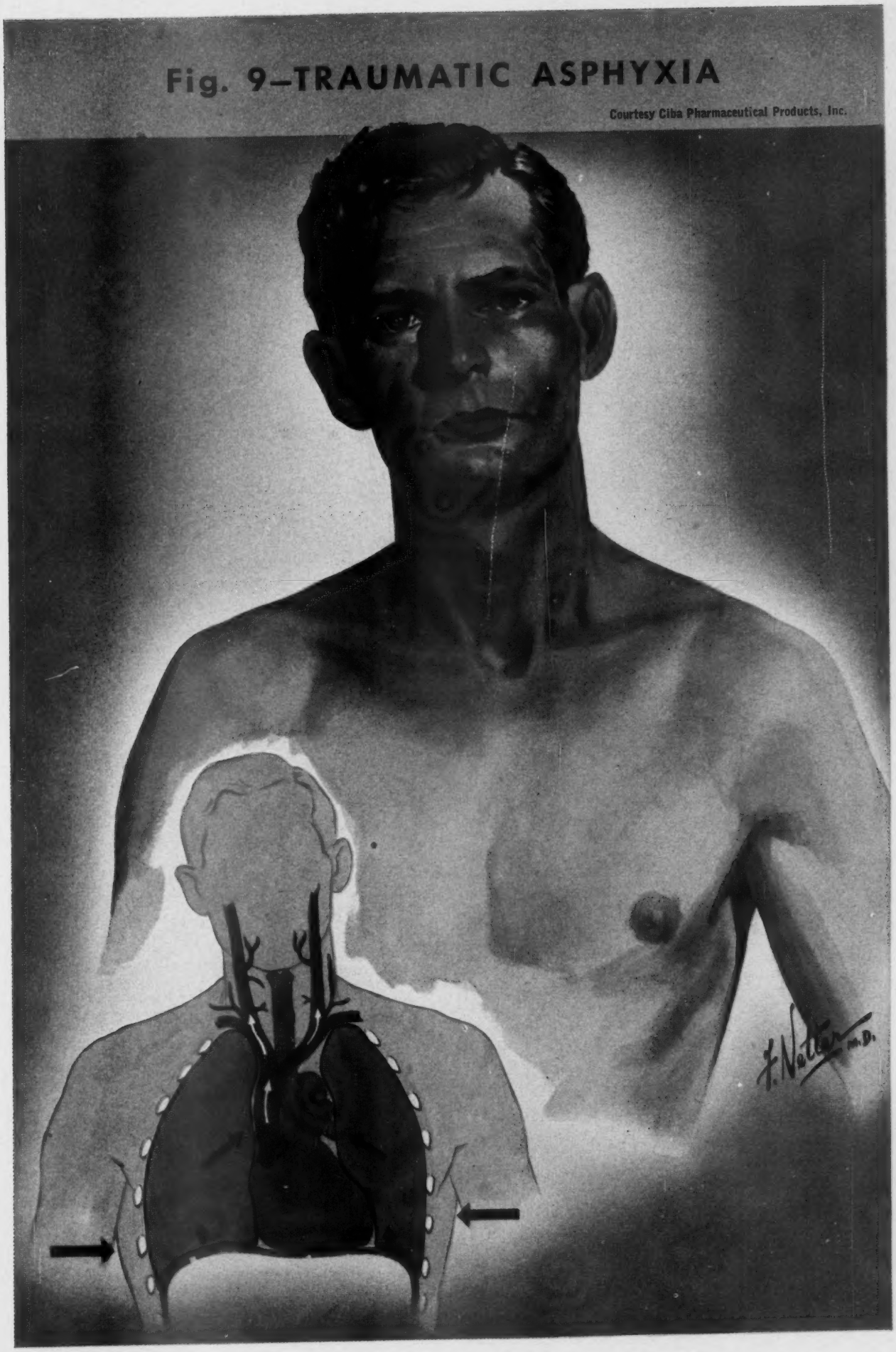


Fig. 10—CHYLOTHORAX

Courtesy Ciba Pharmaceutical Products, Inc.

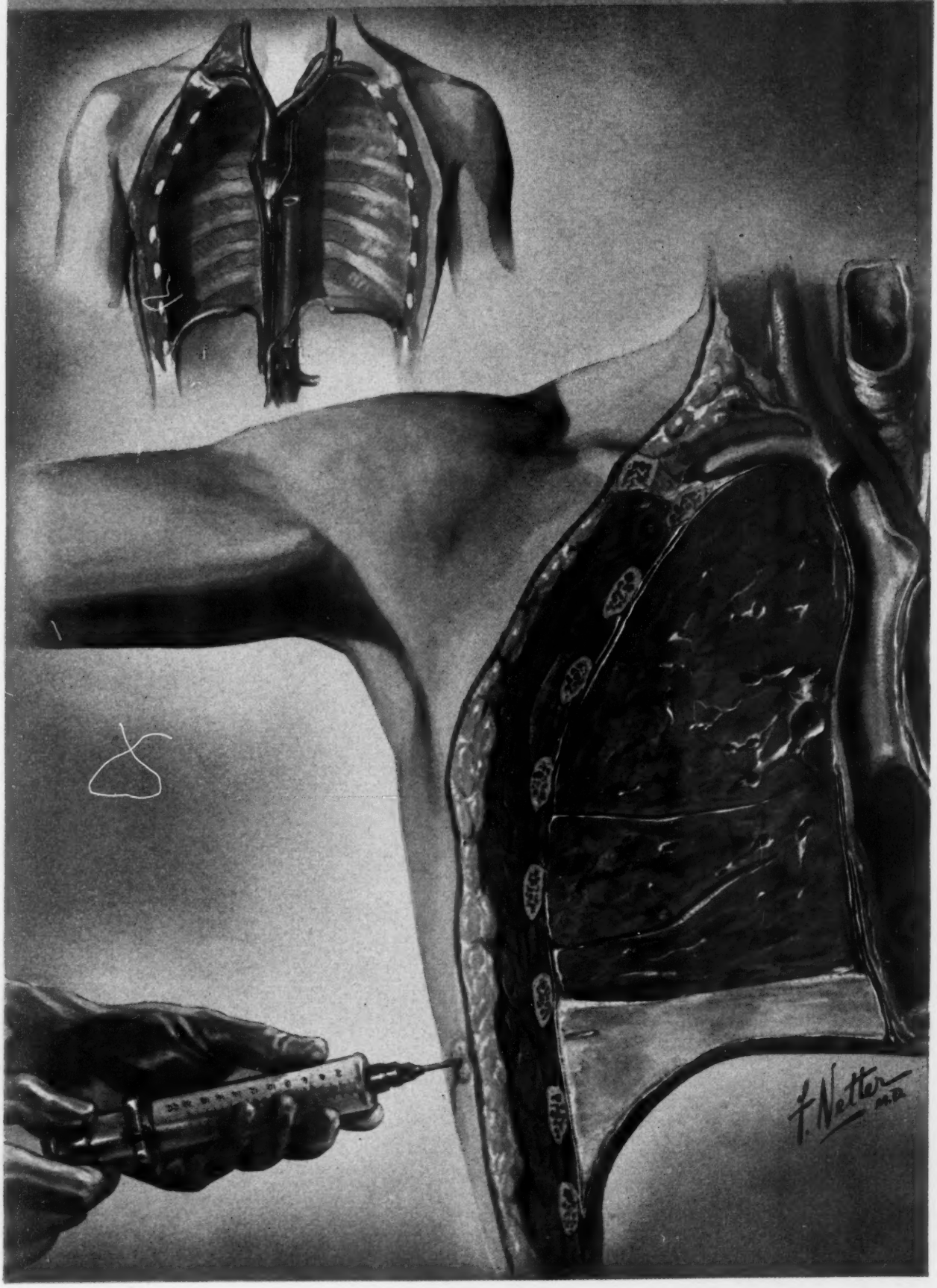
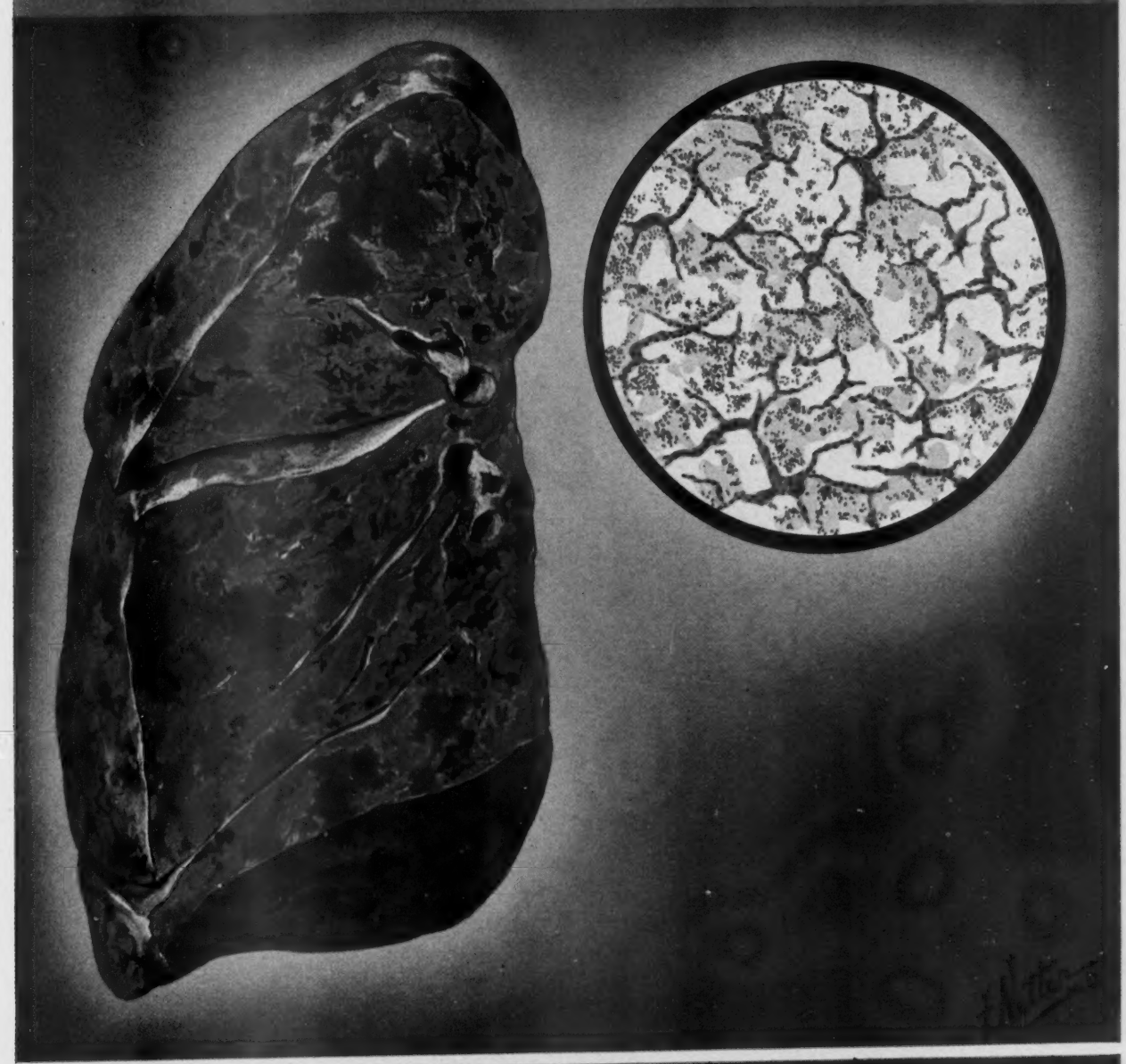


Fig. 11—BLAST INJURY

Courtesy Ciba Pharmaceutical Products, Inc.



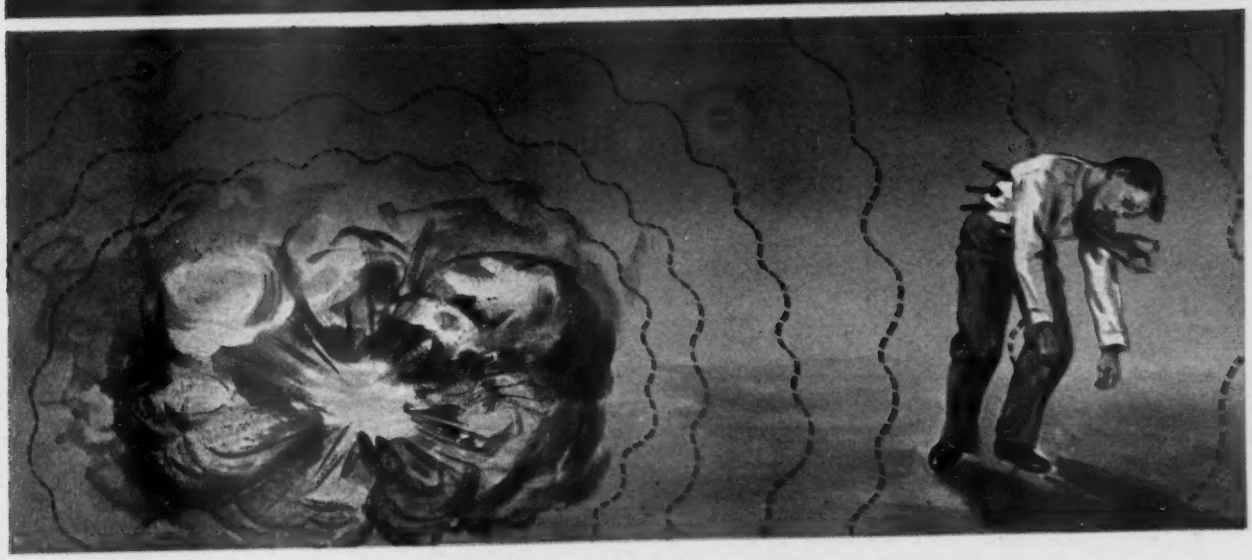
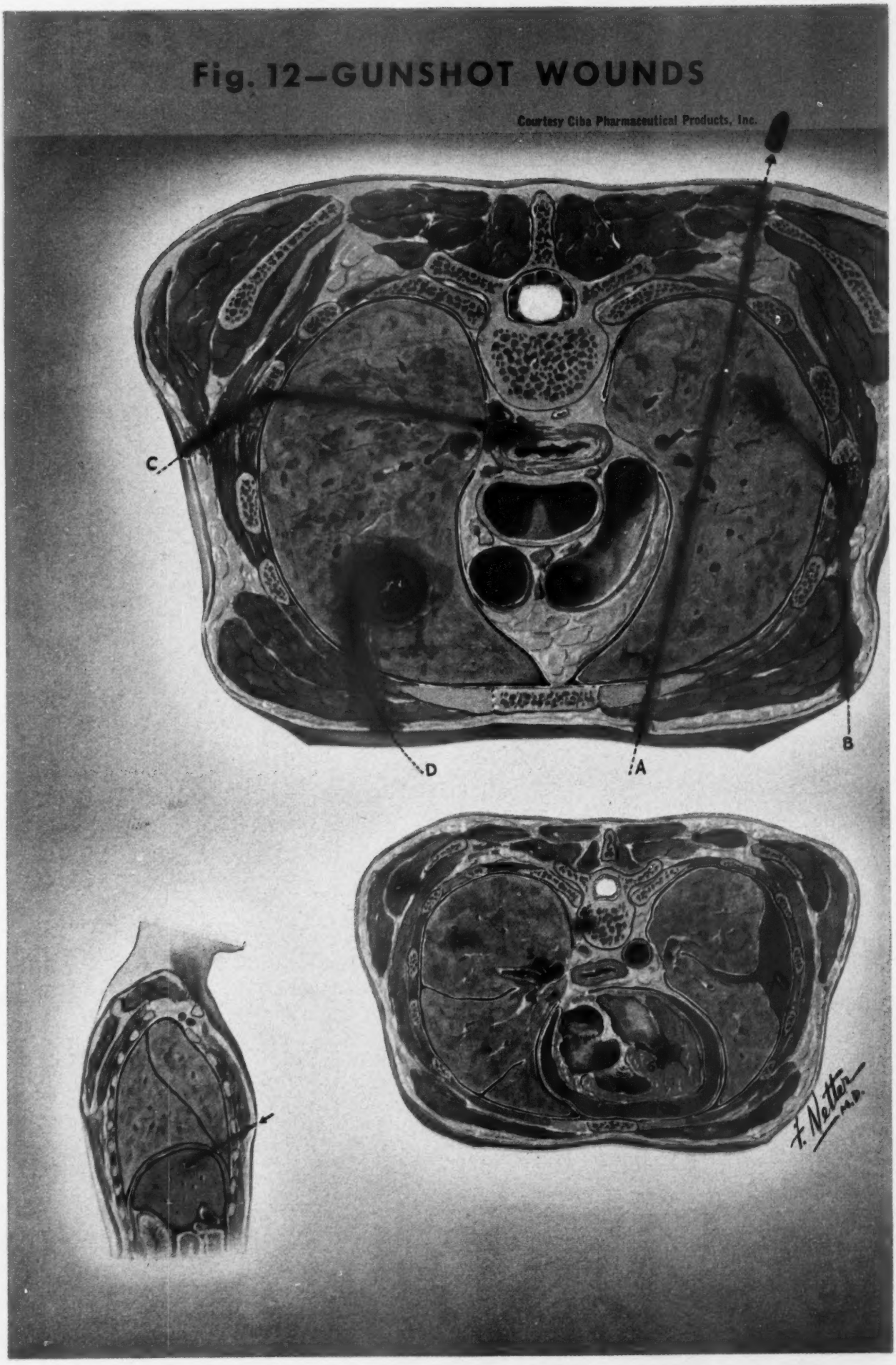


Fig. 12—GUNSHOT WOUNDS

Courtesy Ciba Pharmaceutical Products, Inc.



phere, but changes with inspiration and expiration. The intrapleural pressure is normally negative because of the elastic recoil force of the lungs. The two elastic lungs pull like evenly balanced springs on each side of the mediastinum. The lungs are held out against the chest wall in a state of tension by the negative pressure in the pleural sacs. If one pleural cavity is opened, the underlying lung is released and recoils toward its point of fixation at the hilus. The collapse of the lung is primary, and draws the air into the pleural cavity. The air does not rush in and compress the lung.[114] Formation of a pneumothorax upsets the balance of the lung pull on the mediastinum, and the heart is drawn toward the unaffected side by the undisturbed traction force.

Treatment. No active treatment is indicated other than rest and sedation as the air is absorbed by the pleura. Aspiration of air is rarely indicated. The semi-upright position will lessen the discomfort of the patient.

Valvular, Tension or Pressure Pneumothorax. This type contains air under an increasing positive pressure subsequent to a crushing injury or penetrating wound with a valve-like laceration of the lung or chest wall. Air is taken into the pleural cavity with each inspiration but cannot leave with expiration. The tissues surrounding the injured area act as a one-way valve and admit more air than can be expelled. Littlejohn[97] does not believe a valvular opening in the parietes produces a pressure pneumothorax.

In a tension pneumothorax the affected lung is collapsed and compressed against the mediastinum by the increasing positive pressure. The latter displaces the mediastinum toward the opposite side with encroachment upon the volume of the opposite lung. There is a downward displacement of the diaphragm on the involved side.

Disturbance of the circulation occurs more rapidly on the right side because of direct pressure on the great veins, and the right auricle limits the diastolic flow to the heart. Clinical signs revealed are labored respirations, increasing dyspnea together with tympanitic note and shifting of the trachea, apex beat and mediastinum toward the unaffected side.

Tension pneumothorax unless artificially relieved will result in a fatality. As the syndrome progresses, a bulging of the intercostal space may be observed.

Treatment. Blades[12] advises simple aspiration of air, which may be performed in the second interspace about two inches from the sternum or about the sixth or seventh interspace in the posterior scapular line. Air under pressure escapes with a whistling sound. Simple aspiration of air or continuous aspiration under water drainage may be necessary. (Fig. 6.)

Intercostal thoracotomy with closed catheter drainage may be substituted in those cases in which air continues to escape under pressure. The catheter is removed as soon as air ceases to escape, usually twenty-four to forty-eight hours.

Thoracotomy is employed in those cases in which the tension pneumothorax recurs in spite of the aspiration. The pulmonary laceration emitting the air is sutured. Closure of the chest wall is effected by suturing the wound or by suturing the lung into the wound with institution of closed drainage. Some cases will require open operation with suture of the pulmonary laceration or closure of the parietal wounds.

Open Pneumothorax. The pleural cavity communicates with the exterior through a wound in the thoracic parietes. There is free entrance of air during inspiration and free exit of air during expiration. If the tear in the lung is on the mediastinal surface with involvement of the adjacent mediastinal pleura, emphysema will complicate the picture.

Open pneumothorax is frequently caused by tangential injuries. The patient presents cyanosis, respiratory distress and a hissing sound of air on inspiration and expiration, as the air enters and leaves the thorax through the wound. Blood and air are

sucked into and escape from the wound during respiratory movements.

The pleura is exposed to gross contamination and there is considerable loss of heat due to the excessive ventilation of the pleural cavity. The lung is thrown back and forth into the wound, and the mediastinum flaps back and forth (flutters). There is also a movement of air from the more collapsed lung during inspiration and in the reverse direction during expiration (pendulum air). If the pleural opening is larger than the tracheal opening, air will enter more freely through the wound than through the trachea. Since air drawn directly into the pleural cavity cannot reach the respiratory epithelium, it is useless and this will lead to progressive asphyxia. The mediastinum is forced toward the unopened side in inspiration and back toward the opened side in expiration. Mediastinal flutter subjects the heart and great vessels to varying degrees of positive and negative pressures, and interferes with the emptying of the large mediastinal veins and the filling of the right auricle. Lillienthal during the last World War found a mortality rate of 34 per cent, which was a larger death rate than in any other class of thoracic wounds.

Treatment. The emergency treatment (Fig. 6) of open chest wounds is, first to control the hemorrhage, then to re-establish the normal negative pressure relationship of the pleural cavities. An emergency occlusive dressing to plug the wound and steady the mediastinum is imperative.[97] Use of an occlusive dressing with waterproof material is desirable. The chest wall should be strapped. Littlejohn[97] urges suturing of sucking wounds rather than packing. If a tension pneumothorax develops, aspiration must be undertaken at once. Barrett advocates suturing the muscles over the defect but not the skin. Delayed primary suture can then be done at the base hospital.

The temporary emergency treatment is followed by open operation under positive pressure anesthesia, as soon as circumstances permit. This consists of wound débridement with removal of loose rib fragments and devitalized tissues. The pleural cavity is explored, accessible foreign bodies are removed and the wounds in the intrathoracic organs are repaired. The parietal defect is closed after obtaining full expansion of the lung. Airtight closure can be effected by the use of the diaphragm, muscles of the thoracic wall or suture of the lungs to the margins of the thoracic wall.[63] Closed drainage is instituted at the dependent portion of the pleural cavity away from the wound in the thoracic wall. The superficial portion of the wound is packed, following the local application of chemotherapy. The gauze used for packing is anchored to the skin margins to prevent retraction into the pleural cavity.

Open or tension pneumothorax precludes the use of airplane for transportation, unless high concentrations of oxygen inhalation are available.

EMPHYSEMA

Subcutaneous emphysema results from a laceration of the lung and parietal pleura allowing the air from the bronchial passages to escape into the subcutaneous tissues. (Fig. 7.) It may be caused by penetrating or non-penetrating trauma, more commonly as a result of laceration of the lung by missiles or rib fragments. A tearing of the lung at the site of a pleural adhesion, or subcutaneous rupture of the larynx or trachea may occasionally cause a subcutaneous emphysema.[113] This is recognized by the subcutaneous swelling and crepitation about the chest, axilla, face or in the other lax subcutaneous tissues.

Treatment. Air will absorb spontaneously under conservative therapy. Multiple needle punctures in the subcutaneous tissues or repair at the site of air leak is rarely indicated in this type.

Mediastinal emphysema is a result of a penetrating or crushing injury with a tear of the trachea, a large bronchus[13,28,87,109] or of the esophagus, with escape of air into

the meshes of the mediastinum. This produces serious compression of the mediastinal structures with resultant dysphagia, cyanosis, extrapericardial tamponade, circulatory failure and death. It is recognized by the labored respirations, dyspnea, engorgement of the veins of the neck and upper extremities, and crepitation above the manubrium and lower part of the neck.

Air gradually passes upward through the superior thoracic aperture into the superficial tissues. The crepitant areas may extend into the subcutaneous tissues up to the upper extremities and neck[35] or down the chest wall.

Treatment. Transverse incision at the base of neck over the carotid sheath and use of suction drainage will decompress the mediastinum.[29,40,57,150] Large wounds of the trachea, bronchus, and esophagus require surgical closure. Mediastinitis with abscess formation may be a late complication.

MASSIVE COLLAPSE (ATELECTASIS)

Massive collapse of the lung (Fig. 8) may follow either penetrating or nonpenetrating chest injuries.[58,105,112,116] The etiologic factor is the presence of a mucous plug, blood clot or foreign body in one or more bronchi. Crushing trauma often produces a reflex muscle spasm and fixation of the chest wall, and as a result of the loss of lung movement, mucous plugs or blood clots may fill a bronchus or several bronchi and produce a massive collapse of the lung. The collapse may be limited to a few lobules or involve an entire lobe, lung or opposite lung.[159] Occasionally, multiple small areas of atelectasis may occur following trauma.[83]

A sudden rise in temperature to 103°F., with increased pulse and respiratory rates are important clinical signs. The patient complains of dyspnea, which frequently is out of proportion to the degree of pulmonary involvement present. The presence of cyanosis will depend upon the amount of pulmonary tissue involved. Productive cough is present with mucopurulent or bloody sputum. Another clinical type of atelectasis may result in collapse without chest symptoms or cardiorespiratory embarrassment.

There is restriction in respiratory excursion of the involved side and elevation of the diaphragm. The heart, trachea and other mediastinal structures are pulled toward the affected side and respiratory excursion of the affected side becomes diminished. Narrowing of the intercostal spaces may be visible. Percussion note ranges from dullness to flatness. The breath sounds are distant, absent or bronchial in character.

The shrinkage comes from the contraction of the elastic fibers of the lung and from the active absorption of the air from the alveoli by the blood vessels.[16] The rapid contraction of the lung implies the rapid production of a high negative pressure. The falling in of the chest wall and the rising of the diaphragm compensate for this but to a small extent; the mediastinum and heart are, therefore, drawn violently over to the affected side, while the opposite lung becomes distended and emphysematous.

Radiographs show increased density of the lung with a marked shift of the heart and structures of the mediastinum toward the affected side. There is an elevation of the diaphragm and a narrowing of the intercostal spaces.

Treatment. Simple measures, such as postural drainage with elevation of the foot of the bed, rolling the patient on the uninvolved side and inciting the cough reflex should be tried. Thumping of the chest wall to dislodge the occluding plug may be of value.

Bronchoscopic removal of the plug[132] will allow normal aeration of the involved lobe or lobes and restoration of the normal physiological interchange of gases within the alveoli. The inhalation of 5 or 10 per cent carbon dioxide and oxygen mixture at hourly intervals will often help expand the lung or the lobe that has been collapsed.

TRAUMATIC ASPHYXIA

Crushing injuries of the chest wall cause compression of the thorax and may be followed by two definite clinical types of asphyxia.[17,78,92] (Fig. 9.)

Laird and Borman[94] contend that among the factors responsible for the morbidity of this condition are the occurrences of panic in large crowds, the collapse of structures seating or housing large groups of people, human negligence, our desire for speed, and the consequent use of machinery in industry and vehicles for rapid transportation.

1. *Pale Type.* In this type the respiratory movements are superficial, irregular and uneven.[47] There is a pallor of the face or neck with areas of purplish discoloration. The pulse is weak, rapid and thready. The skin is cold and clammy.

2. *Ecchymotic Type.* DeBakey[37] describes this condition as a violet blue discoloration of the face, neck and occasionally the upper chest and shoulders are involved. The bluish or purplish discoloration is strictly limited to the distribution of the valveless veins of the head and neck. In this area multiple petechial hemorrhage and stasis of blood in the tiny skin vessels is observed. The buccal and pharyngeal mucous membranes show similar minute ecchymotic or petechial hemorrhagic spots. Hemorrhage into the subconjunctival tissues with protrusion of the eyes and swelling of the lids and tongue usually adds to this terrifying picture. There may be coma from intracranial hemorrhage or blindness from choked disk.

Wise[170] aptly states that extravasation into the subconjunctival tissues with protrusion of the eyes and swelling of the lids presents a never to be forgotten picture.

The sudden rise in intrapleural pressure causes a collapse of the mediastinal veins. The blood is forced back from the right heart and great thoracic veins into the valveless veins of the neck and face.

There may be associated lesions, as fractures of ribs or other bones, cerebral congestion,[133] intrathoracic hemorrhages,[121] and intra-abdominal laceration or hemorrhagic infiltration of the viscera.[78]

Treatment. Sedation, oxygen therapy, respiratory stimulants and supportive treatment may be necessary. Associated injury as ruptured diaphragm or abdominal viscera must be ruled out. Prognosis is good with a recovery period of seven to twenty days.

CHYLOTHORAX

Anatomy of the Thoracic Duct. The thoracic duct (Fig. 10) originates in the cisterna chyli at the level of the first and second lumbar vertebrae to the right of the aorta. It traverses the aortic opening of the diaphragm and ascends through the posterior mediastinum between the aorta and azyges vein, to the level of the fifth thoracic vertebra, where it crosses to the left side of the aorta. It then ascends through the superior mediastinum to the root of the neck where it turns laterally and then forward to empty into the left subclavian vein or innominate vein at its junction with the internal jugular vein.

Injuries to the Thoracic Duct. Although uncommon, duct injuries[102] may result from indirect violence.[5,6,25,59,106,145,154,162] Trauma to the thoracic duct more frequently results in a chylous effusion into the right pleural cavity as the duct is situated on the right side for two-thirds of its thoracic course.

The thoracic duct may be indirectly injured by sudden and exaggerated hyperextension of the thoracic spine. Tearing of the duct is more likely to occur immediately after a heavy meal, when the duct is distended with chyle. It may be directly injured by gunshot, shrapnel or stab wounds. The primary trauma usually overshadows the findings of thoracic duct damage. There is a latent period of about four days before the evidence of duct damage makes its appearance. The early picture is one of effusion into the pleural cavity, followed by inanition and exhaustion.

Radiographs of this condition show a picture similar to that of hemothorax. The aspirated fluid is a milky, non-coagulable opalescent substance containing fat[39] and may be easily mistaken for pus. This fluid is alkaline in reaction, has a specific gravity of 1012 or higher and settles into an upper milky layer and a lower bloody layer.

The prognosis is poor; death generally ensues from inanition and exhaustion.

Treatment. The treatment is surgical repair of the duct, but the operation is extremely difficult and the outcome doubtful. Conservative measures consist of repeatedly aspirating the chyle from the pleural cavity and replacing it into the blood stream by intravenous injection.[5,149,164]

BLAST INJURY

Concussion of the lung as related to detonation of high explosives was observed in World War I. The British have carefully studied this condition which they call "blast injury." (Fig. 11.) Similar forms of thoracic injuries were observed in the recent Spanish Civil War.[92,147]

Blast injury[26,50,64,93,122,123,134,135,155,169,174] is a distinct clinical entity which follows severe, non-penetrating chest injuries with clinical manifestations varying from a slight degree of respiratory distress to a complete cessation of respiration. There is generally no injury to the chest wall. Elolesser[48] states that this entity may be combined with traumatic asphyxia.

The lung injury is due to the detonation of high explosives,[90] therefore, all people rescued from the vicinity of an exploding bomb must be suspected of having a lung blast injury. Zuckerman[175] in a recent investigation on experimental animals has shown that these effects are produced by the compression wave of air upon the chest wall and that the protection of the chest wall prevents damage to the underlying lungs.

The mechanism of this condition is not yet satisfactorily explained. It has been suggested that the blast wave set up in the surrounding air may cause sudden distention of the lungs by acting through the respiratory passages or that the succeeding suction wave may lower the alveolar pressure with consequent rupture of the alveolar capillaries.

Theories. Some of the theories are: (1) Lesions are due to a lowering of alveolar pressure by the suction wave, acting through the respiratory passage with consequent rupture of the alveolar capillaries; (2) lesions caused by distention of the lungs with air, and (3) lung lesions are due to the impact of pressure wave on the chest wall.[81]

The experimental work of Zuckerman[174,175] appears to prove that the lesions are probably due to impact of the pressure wave on the chest wall. He has shown that when a rabbit's chest wall is enclosed in a rubber sponge jacket there was no pulmonary damage, after exposure to blast; whereas if one side of the chest was protected and the other side unprotected, the unprotected side showed evidence of blast injury.

Gross Aspect. The lungs show general congestion and extensive deep parenchymal hemorrhage, which may extend to the surface and produce what appear to be subpleural hemorrhages.

Microscopic Aspect. Alveolar walls and capillaries are disrupted. The alveoli and bronchioles are filled with blood. Some effusion is present throughout the interstitial lung tissue.

Patients suffering from blast may show little or no evidence of injury other than a slight bloody froth from the mouth. Damage to other viscera may be coexistent. The most common finding is expectoration of frothy, blood-stained sputum. There may be varying degrees of shock, cyanosis and dyspnea. Pneumonic consolidation may be a late complication.[64,122]

As a rule there are no fractures or external signs of injury. Such findings are fairly common in children, due to the elastic nature of the thoracic cage, resulting

in compression of the lungs between the resilient ribs. It is unlikely that the pulmonary damage is responsible for either sudden death or later fatalities except as a contributory factor. Stewart suggests that a cerebral lesion may result from the sudden hydraulic compression on the central nervous system in its firm encasement, resulting from sudden compression of the thoracic cage with violent back pressure on the venous side.

Prevention. Blast injury may be prevented by the use of a protective jacket about the chest wall or use of air raid shelters or trenches preventing the blast wave from contacting the body wall.

Therapeutic Treatment. The treatment is symptomatic and supportive. Complete rest and oxygen inhalation should be instituted.[169] Chemotherapy may be used for its bacteriostatic action.[134]

THORACIC WOUNDS

The increasing use of explosive missiles has created a rise in the incidence and severity of thoracic wounds. Penetrating and perforating explosive wounds result in greater cardiorespiratory disturbance and tissue damage. These pathological factors plus the retention of foreign bodies enhance the predisposition to infection.

Gunshot wounds (Fig. 12) sustained by civilians are usually from plain or jacketed bullets. In warfare, on the other hand, penetration and perforation is more apt to be caused by machine gun bullets or shell fragments.[66]

In civil life, chest wounds are mostly of the stab or closed penetrating type in which extensive tissue injury, disturbance in cardiorespiratory physiology, and the development of infection are minimal. For these reasons chest wounds occurring in civil life are more readily adaptable to conservative management.[37] On the other hand, in penetrating war wounds of the chest, operative intervention is more frequently indicated.[62,78,99,171]

Examination for signs of air or fluid in the pleural cavity, and frequent determinations of the temperature, pulse rate, blood pressure, and the apex beat of the heart are important. Roentgenographic studies will reveal retained foreign bodies, mediastinal displacement, pneumothorax, and collapse of the lungs.

Early operation was advocated by Duval[41] and Gask[56] and substantiated by more recent contributors.[20,92,110,117,132,156,157]

Walker[163] states that 60 per cent of the war casualties are accounted for by gunshot wounds of the chest, and it is stated that 40 per cent of the deaths in the field are due to such injuries.[80] A large number of soldiers in the front lines are killed by small fragments of grenade or shell piercing the front of the chest, with resultant tearing of the heart or the roots of the great blood vessels, and causing almost instantaneous death.

There is a high mortality rate as a result of penetrating wounds of the chest. It is difficult to obtain complete records from the battlefield, as many men with gunshot wounds die immediately.

Sauerbruch, in 1914, counted 300 dead soldiers on a battefield and found that 122 (37 per cent) had gunshot wounds of the chest. In the American Army during the first World War,[107] there were 174,296 admissions resulting from battle injuries. Among this number, the thoracic region was involved in 4,595 cases, being preceded in frequency by involvement only by the limbs, the head and face. While the total mortality was 7.73 per cent, that of the chest wounds was 24.05 per cent.

Trueta[160] found that of 9,850 patients treated in different hospitals in Barcelona, 12.1 per cent had thoracic injuries, an incidence second only to that of injuries of the limbs.

Ryle[138] studied a series of 130 cases of penetrating wounds of the chest in 1917, the total mortality being 23 per cent. In approximately 60 per cent of the cases there was no indication for surgical intervention.

In the Sino-Japanese War, Ranson[128] found one wound in every twelve was of the thorax. Some observers have given

figures well over 33 per cent of the total killed.[30] Hardt and Seed[66] in a series of 280 cases found in the fatal cases that the vast majority of entrance wounds were inflicted on the left side of the anterior aspect of the chest, while in the non-fatal cases the path of the projectile rarely involved the mediastinum. Boland[15] in a series of 1,009 cases at the Grady Hospital in Atlanta found 85 per cent of chest wounds were penetrating and 15 per cent were non-penetrating. Of the former 75 per cent were stab wounds and 21 per cent were gunshot wounds. Infection occurred in less than 20 per cent of the cases. Elkins[47] in a series of 553 cases found infection in 1.04 per cent of the injuries. Yates[171] states that 80 per cent of chest injuries in warfare are comprised of penetrating wounds associated with visceral damage.

The end result will depend upon many factors, as the type and location of the missile, the geographic site of the battlefield and the speed with which first aid treatment is rendered and the patient removed to the base hospital.[63]

The course of a missile is unpredictable. A missile traversing the upper chest wall will pass through thick muscle layers which tend to close in the track and prevent communication of the pleural sac with the atmospheric air, thereby converting it into a closed chest wound.[144] The lower chest has no such protective covering and large wounds will tear the pleural cavity, producing a sucking wound.

Subcutaneous emphysema is a fairly common finding in penetrating wounds, either from air sucked in through the wound, or more often from air extravasated from the pleural cavity of the lungs.

A bullet may produce a small point-like entrance wound because of its size and high velocity. Explosive missiles are irregular and jagged, they acquire a tremendous spin and drag foreign material and clothing into the wound.

The points of entry and exit do not always indicate that a missile has taken a straight course between these two sites. The size of the entry wound is no criterion of internal hemorrhage. In the Spanish Civil War, minute punctures from small fragments of bombs utterly belied the extent of internal damage and bleeding.[143]

Types of Wounds. 1. Small entrance with no exit wounds (penetrating) are frequently encountered in civil life and are usually caused by plain or jacketed bullets.

2. Small entrance and small exit wounds (perforating[127]) suggest a bullet of high velocity passing through an intercostal space on both sides of the chest. Its long and narrow path is marked by a coagulated and scarred trail.[52] The small exit wound suggests that no bone has been encountered by the missile.

Treatment. Small perforating wounds without any symptoms simply require a sterile dressing over the entrance and exit wounds.[41,62,161] Small bullets may be allowed to remain in the thorax unless in the vicinity of vital structures. The lung tolerates foreign bodies better than the pleura. The optimum time for operation for removal of a foreign body is probably in the second week.[4]

3. Small entrance and large exit wounds (perforating) suggest rib injury close to the exit wound. The shattered bone reduces the velocity of the bullet, thereby increasing the damage to the soft tissues and producing a more extensive wound track. The exit wound may show jagged laceration with spicules of bones or macerated muscle tissue. The bullet may ricochet or be deflected so as to remain within the body at a different level.

Treatment. Débridement of the exit wound should be performed as mentioned under the treatment of compound fractures. Thoracotomy is indicated for persistent signs of bleeding into the pleural cavity, indriven bony fragments and large retained missiles or high explosive fragments.

4. Large entrance wounds with no exit wounds (penetrating) indicate injury due to explosive missiles. Shrapnel wounds are usually multiple and cause irregular jagged wounds. Because of the irregularity and

sharp points of the shrapnel, it almost always carries clothing with it into the wound.

Treatment. These wounds are usually grave. Single large entrance wounds require the same treatment as is discussed under open pneumothorax.

5. Large entrance and large exit wounds are usually fatal. Those patients remaining alive will require treatment as outlined under open pneumothorax.

Bullet wounds usually heal without infection if no clothing or other foreign material is carried into the wound. All patients with gunshot and explosive wounds will require antitetanus and antigas therapy as well as chemotherapy.

DIAPHRAGMATIC INJURIES

The diaphragm may rupture as a result of crushing injuries of the thorax or abdomen or be injured by penetrating missiles.

Diaphragmatic lesions occur more commonly in the sloping muscular portion where it lies in contact with the thoracic wall. The posterior portion of the left side is more frequently involved than the right side.[75] Occasionally, bilateral involvement of the diaphragm may occur.[108] Small wounds may heal, others are plugged temporarily by omentum, spleen, etc. Wounds of the central tendinous part are more serious than those at the periphery. Wounds that traverse the diaphragm from below upward are more grave than the other type. Pain is induced by lifting, coughing and deep respiration. The diaphragm is motionless on the affected side. Hyperresonant percussion note may be present at the left base with absent or diminished breath sounds.

Treatment. Surgical repair is effected as soon as the patient's condition will permit. The subdiaphragmatic space is carefully explored for injuries to the structures in the area. The diaphragm is repaired with interrupted silk or linen thread following excision of the edges of the laceration.[70,103,142,151,166] Repair is performed through the thoracic or abdominal approaches depending upon the type of wound and extent of the thoracic or abdominal damage.

The phrenic nerve is crushed to rest the diaphragm if the transpleural approach is used.[49,68,75] This is facilitated by resection of the ninth and tenth ribs.

Exploration of the abdominal cavity is aided by deflation of the stomach by means of a Levine tube. Harrington reported 210 cases of diaphragmatic hernia including thirty-six of traumatic origin with a total operative mortality of 4.3 per cent.[69]

In the non-penetrating type the most common immediate symptoms are shock, pain, dyspnea, upper abdominal tenderness, rigidity and pain referred to the neck and shoulders.

The penetrating type shows additional associated intrathoracic injury as pneumothorax, hemothorax, etc. The later symptoms will depend upon the size and position of the opening and consequent interference with cardiorespiratory and gastrointestinal functions. These injuries may be easily overlooked and present later symptomotology with difficulty in establishing a diagnosis (75).

ABDOMINOTHORACIC WOUNDS

The abdomen is telescoped into the thoracic cage, thereby producing abdominothoracic wounds when bullets or projectiles penetrate the chest wall transversely or anteroposteriorly within the limits of the broad belt that extends posteriorly from the ninth intervertebral cartilage to the lower border of the twelfth rib and laterally from the fifth to the twelfth rib.

The upper limit of the abdominal cavity reaches the level of the upper border of the fifth rib anteriorly on the right side and the fifth intercostal space anteriorly on the left side. The lower limits of the pleura are usually the lower border of the ninth rib in the mid-axillary line and the twelfth rib posteriorly.

Penetrating wounds of the trunk passing between the ninth intervertebral disc and the twelfth thoracic vertebra are likely to involve both thoracic and abdominal cavities.

The chest and abdomen may be penetrated by separate missiles or missiles may pierce the chest and emerge through the abdominal wall to be retained within the abdomen or vice versa.[44,60,97]

Missiles which traverse the diaphragm from below upward produce more grave injuries than those which occur from missiles traversing above downward.

Crushing injuries may result in thoracic-abdominal lesions with rupture of the liver or spleen.[32]

The clinical manifestations are variable and depend upon the extent and type of visceral involvement. Thoracic findings will co-exist with abdominal tenderness and rigidity of the upper abdominal wall. This must be differentiated from pseudoperitoneal reactions which occur in lower thoracic injuries. Gordon-Taylor[60] states that the abdominal rigidity is more likely to be unilateral and intermittent in thoracic injuries.

The blood pressure in the pulmonary circulation is about one-sixth that of the abdominal circulation, a fact which renders bleeding in the lungs more easily controlled than in the abdomen.

Abdominal signs and symptoms in the presence of a chest injury are not always indicative of an intra-abdominal lesion.[148] Injuries to the intercostal nerves or non-penetrating wounds of the diaphragm may cause abdominal pain, tenderness and muscular rigidity.[122]

Intrathoracic wounds may also produce retroperitoneal injuries of the duodenum, pancreas and kidneys.

Edwards[44] observes that "abdomino-thoracic" wounds are associated with a high mortality. Loria[101] quotes a 62.28 per cent mortality rate in a series of 228 cases. Gordon-Taylor[60] gives the recovery rate of abdomino-thoracic wounds in 1916 as about 18 per cent. In the present war in a series of over 600 operations for abdominal injuries, he found penetrating abdomino-thoracic injuries to constitute about 13 per cent of the abdominal injuries. The recovery rate was 63 per cent. Seventy per cent of the patients with abdominothoracic wounds of the right side recovered; only 50 per cent of those with involvement of the left side survived. No patient with abdominothoracic injury implicating the hepatic flexure of the colon survived in his series.

In the Spanish Civil War these wounds comprised 11 per cent of all abdominal wounds.[85]

Treatment. Surgeons have variously advocated opening of the chest or abdomen first.[3] Bailey[4] advises emergency treatment of the chest injury, primarily because of the narrow margin of safety from sudden derangement of the normal thoracic visceral relationships. The transpleural route has the advantage of immediately equalizing the pressure in the thoracic and abdominal cavities and thus making reduction of the prolapsed abdominal viscera easier.[27,63] It also permits access to the phrenic nerve, which should be lightly crushed to facilitate the repair of the diaphragm.[153]

When the thoracic hemorrhage has been controlled, respiratory balance regained and the patient recovered from shock, exploration of the abdominal injury may be undertaken.[26]

Gordon-Taylor[60,61] summarizes the present day treatment of penetrating abdominothoracic injuries as follows:

"Through and through abdomino-thoracic wounds of the right side require no active surgical treatment provided there is no involvement of the thoracic or abdominal wall or peritoneal cavity. Accessible fragments lodged in the lung should be removed.

"In open pneumothorax, the chest assumes chronological priority of treatment.

"If the position of the wound of entry and exit in an abdomino-thoracic wound involves the left subphrenic area of the abdomen, the thorax should be dealt with

first and access to the upper abdomen obtained through the diaphragm.

"When the thoracic injury appears insignificant, but there is evidence of intraperitoneal damage, the abdomen is explored through a laparotomy incision.

"When the thoracic injury is slight and a through and through wound suggests an extraperitoneal course of a small fragment, such injury may be left alone.

"If an abdomino-thoracic injury has been approached from the abdominal aspect, it is important not to waste time trying to complete a difficult suture of the diaphragm in a critically ill patient, unless the aperture in the midriff is so large that immediate or early herniation of the abdominal contents is certain to occur."

ANESTHESIA IN THORACIC WAR WOUNDS

There is considerable diversity of opinion regarding the choice of anesthesia in these cases.[3] The most important factors are complete control of intrapulmonic pressure, adequate facilities for aspiration of secretions in the respiratory passages during the operation, the maintenance of quiet respirations and high oxygenation, the avoidance of distressing cough reflex, and the rapid return to consciousness following completion of the operation.[120] Differential pressure anesthesia is essential for accurate appraisal of the injury.

Procaine block of the intercostal nerves and subpleural perihilar infiltration blocks the cough reflex but has the disadvantage that few patients escape without considerable shock and pain.[127]

Halton[65] considers intratracheal insufflation the method of choice in either immediate or delayed procedures with the use of ether or chloroform.

Westell[167] prefers intravenous anesthesia combined with endotracheal insufflation of oxygen under pressure, supplemented by nitrous oxide if necessary.

Nosworthy[118] claims he has seen no ill effects arise from the use of sodium pentothal in patients who are "blue" from the previous administration of one of the sulfonamide group of drugs. In view of its marked respiratory depressant action, its use may be contraindicated on other grounds and in no instance has he injected more than ½ Gm.

Crafoord[31] points out that controlled automatized respiration under anesthesia gives absolute rest to all the respiratory muscles and a quieter operative field than any other method. The importance of mechanically automatized breathing with rhythmic insufflation during the inspiratory phase and free outflow of gas during the expiratory phase during open chest operations is stressed.

Beecher[7,8] believes the anesthetist who is familiar with the problems of anesthesia for thoracic surgery can make it possible for the thoracic surgeon to proceed with deliberation in exploring thoracic wounds of warfare. It is the anesthetist who makes it possible for the surgeon to exercise the deliberation necessary for the proper control of hemorrhage, proper débridement of the wound, and to determine carefully what shall be done at once and what postponed. It is the anesthetist who makes it possible for the surgeon with only a general training to work with success in this field.

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TRAUMATIC RUPTURE OF THE GASTROINTESTINAL TRACT BY NON-PENETRATING FORCES*

N. Frederick Hicken, M.D. and John H. Carlquist, M.D.
SALT LAKE CITY, UTAH

TRAUMATIC rupture of the gastrointestinal tract is a dramatic catastrophe which usually has a fatal termination. The appalling mortality is due not to our inability to repair the damaged bowel but rather to our ineptitude in arriving at an accurate diagnosis during the curative phase. All too frequently the provocative accident seems so trivial that it fails to focus attention on the injured viscera or the accompanying shock may be so severe that it completely masks the perforative syndrome. It is not until a fulminating peritonitis develops that a true evaluation is made.

MECHANISM

Subparietal ruptures of the gastrointestinal tract are produced by traumatic forces which operate through an intact abdominal wall. While the destructive forces may be classified as crushing, tearing, and bursting, the actual damage is generally produced by a combination of these three agents. Usually the traumatizing force is of such violence that it not only overcomes the resistance of the abdominal wall but also macerates the bowel against such unyielding structures as the vertebrae and pelvic bones. Occasionally, indirect trauma, such as jumping down from an embankment or falling from a scaffold, may cause the jejunum and ileum to jerk so violently on their ligamentous and mesenteric attachments that the bowel is torn. Falling on an overdistended stomach has produced a bursting rupture of this viscus.[4] Lacerations of the mesentery may precipitate an acute intra-abdominal hemorrhage or initiate a segmental gangrene of the bowel. The ileum, jejunum, duodenum and stomach are affected in the order mentioned.

Subparietal ruptures of intestines which become incarcerated in hernial sacs occur so frequently as to necessitate special mention. Wilensky and Kaufman[5] collected forty-three instances in which indirect muscular trauma of the herniated bowel resulted in perforative lesions. Sometimes the provocative insult was most trivial, such as, sneezing, coughing, lifting a barrel, stumbling, urinating, defecating, pressure from an ill-fitting truss, attempted manual reductions and wrestling.

SYMPTOMS

Traumatic rupture of the intestinal tract within a closed abdomen produces no pathognomonic syndrome but can and does mimic every other type of abdominal emergency.

The majority of patients are first seen in the state of primary shock which may be so pronounced that it successfully masks the perforative syndrome. Hypothermia, hypotension, sweating, and a weak ineffective tachycardia signifies the shocked state. These symptoms are usually transient unless aggravated by extensive internal hemorrhage or damage to the visceral and skeletal systems. When the patient rallies from the shock he usually complains of a dull aching pain confined to the zone of trauma. Nausea, vomiting, hyperthermia, and septic reactions announce the onset of a peritonitis.

Intra-abdominal hemorrhage frequently complicates the clinical picture. Lacerations of the mesentery and contusive ruptures of the liver, spleen, pancreas and kidneys may precipitate such a rapid

* From the Departments of Surgery and Pathology, University of Utah Medical School.

exsanguination that the patient succumbs at the scene of the accident. Hematemesis and melena indicate injury to the bowel wall. It is imperative that determinations of the pulse rate, changes in blood pressure and leucocytic responses be made frequently in order to evaluate the severity of the hemorrhage.

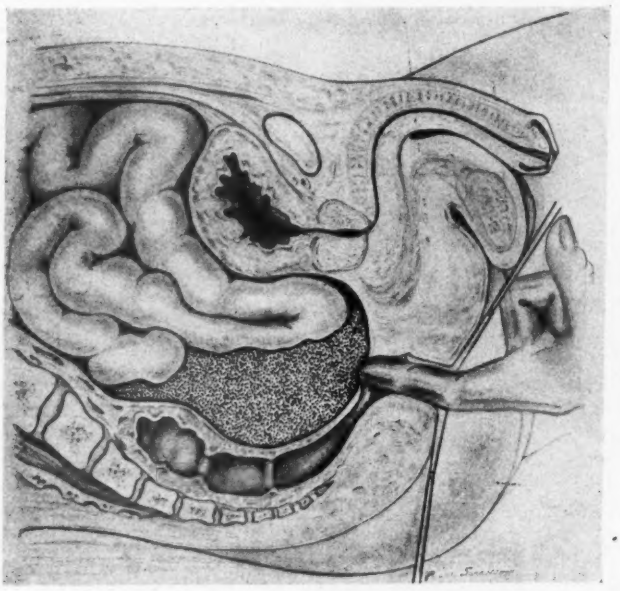

FIG. 1. Blood and visceral fluids tend to collect in the rectovesical space. They form a soft fluctuant mass which can be detected by rectal examination.

The physical examination is usually very informative but it may reveal so few findings that both the surgeon and the patient are lulled into a sense of false security. One must remember that the shocked patient does not make a normal response to peritoneal irritations. Localized abdominal tenderness, regional muscular rigidity, tympanities, and a leucocytic increase are the most valuable signs. Occasionally a soft, fluctuant mass can be palpated in the rectovesical space indicating the presence of blood or visceral fluids (Fig. 1), the nature of which can be determined by colposcopic aspirations. In one such instance bile-stained pus was recovered, thus confirming the impression of a ruptured jejunum, and on another occasion frank blood confirmed the diagnosis of an internal hemorrhage. A percussion dullness which does not shift with a change of posture is suggestive of a retroperitoneal hematoma.

One must always be alert for the symptoms of a delayed perforation for in 60 per cent of our cases it required from twelve hours to ten days for the actual soiling of the peritoneum to occur. A paralytic ileus may permit a small perforation to become "walled-off" and it is not until the return of active peristalsis that the intestinal contents are forced through the rent.[4] Partial devitalization of the bowel wall, either from contusions or impairment of its blood supply, may result in a slow but progressive ulcerative necrosis which requires several days to errode through the bowel wall.[5] A rising leucocytosis, blood in the feces, and signs of an acute condition of the abdomen are the warning signals of an impending perforation. Purgatives, enemas, and solid foods should be restricted until the period of doubt has passed.

Roentgenograms are particularly informative if one suspects a rupture of the gastrointestinal tract for a pneumoperitoneum is pathognomonic of this condition. Bedside films can be taken while the patient is being treated for the primary shock. Whenever possible the exposure should

be made with the patient in the upright position as this compels the liberated gas to collect beneath the diaphragm. Failure to visualize a "bubble of gas" is no assurance that the intestinal tract is intact as it merely signifies that the gas has not escaped into the peritoneal cavity.[3] A positive diagnosis means much but a negative one has no value. If one suspects a perforative lesion, repeated *x*-rays should be taken every two hours until a correct evaluation has been reached.

Roentgenograms also reveal the presence of an intestinal obstruction by outlining the dilated bowel. Regional accumulations of blood or other fluids may produce incriminating shadows. Dislocations and fractures of the vertebrae, pelvic bones and skull are quickly detected. These complications may play either a minor or major rôle in this traumatic drama but it is essential that all contributing factors are recognized and properly treated.

The differentiation between a perforative lesion and a traumatic peritonism is a tantalizing problem.[2] In the former immediate correction is imperative while in the latter passive conservatism is indicated. Peritonism or neuroperitoneal shock represents the irritative responses of the sympathetic nervous system to the initial trauma. It is particularly prone to occur in severe injuries to the skeletal system. Fortunately, the urgent symptoms of peritonism subside while the patient is being treated for the primary shock. If they persist in spite of energetic therapy, surgical exploration is in order. Careful observation during this early period is essential and affords the only basis for a correct appraisal.

TREATMENT

Counsellor and McCormack[1] studied 1,313 cases of subparietal ruptures of the intestines as reported in the literature and concluded that they were strictly surgical problems. The mortality in the non-operative group was 100 per cent as compared to 60 per cent for those receiving surgical therapy.

Active treatment consists of two phases: that of combating the primary shock and that of correcting existing defects. Counsellor and McCormack[1] have demonstrated that it is more prudent to combat the initial shock before attempting to repair the damaged bowel than it is to reverse this procedure. If the patient responds to the shock therapy within three hours, the prognosis is favorable for corrective measures can be employed before the peritonitis becomes disseminated. If the patient cannot summon sufficient reserve to rally from the shock, certainly he cannot withstand the added insults of an operation.

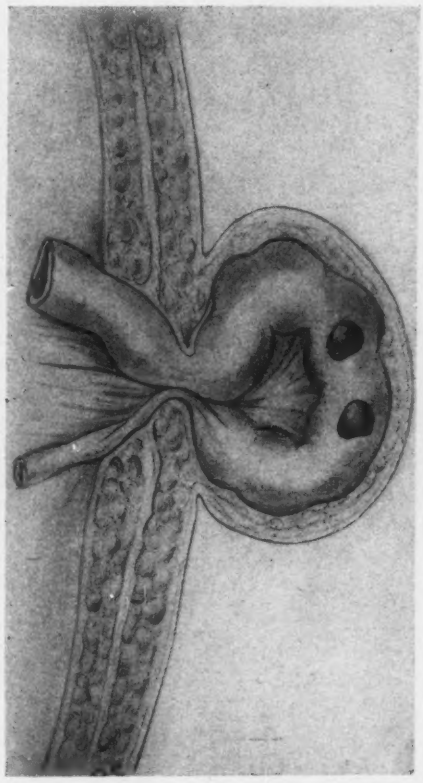

Fig. 2. Intramural hematomas of the transverse colon produced by manual pressure during an attempted reduction of a strangulated hernia. Ulcerative necrosis with the formation of a fecal fistula occurred ten days later. Recovery followed resection of the colon.

It is imperative that hemorrhagic shock be differentiated from the neurotraumatic variety.[2] In the former the loss of blood is the vital consideration and unless the hemorrhage is quickly controlled death

may ensue. Ruptures of the liver, spleen, pancreas and kidneys usually assume lethal proportions but spontaneous cessation does occur as in Case v (Fig. 5). A progressive tachycardia, decreasing blood pressure, air hunger, restlessness, and the presence of a doughy-mass in the rectovesical space is indicative of an internal hemorrhage. In severe lacerations of the parenchymatous organs one must attempt to arrest the bleeding at its source by direct sutures or packing. While any type of intervention is attended by considerable risk one has no other choice. Restoration of the blood volume by repeated transfusions of blood serum, blood plasma and whole blood have been very beneficial.

Spinal anesthesia supplies the complete muscular relaxation which is so essential for a rapid exploration. It can be administered very quickly and renders the entire abdomen insensitive, thereby permitting the desired type of corrective surgery to be employed. Its applicability is evidenced by the fact that it was successfully employed with a nine year old boy. It is supplemented by inhalations of oxygen and the simultaneous administration of either blood or glucose solutions as dictated by the patient's general condition.

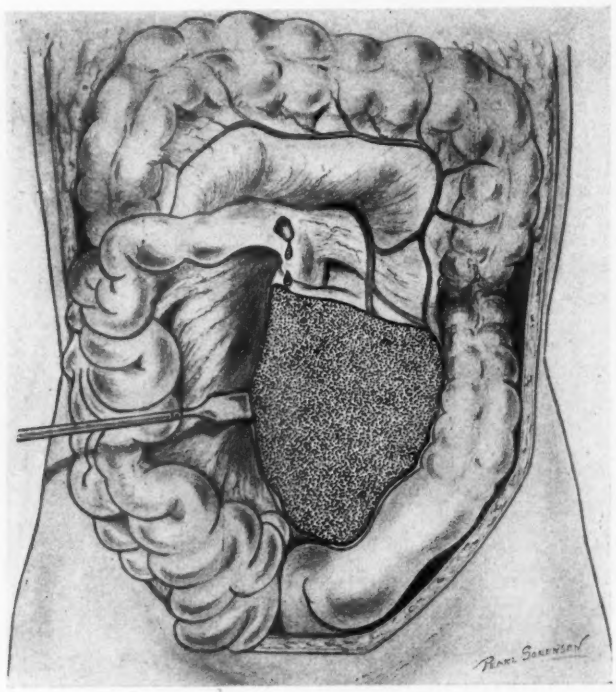

FIG. 3. Traumatic perforation on posterior jejunal wall which occurred three days after the primary injury. The resulting abscess occupied the entire left side of the abdomen and the pelvic gutter.

Reparative procedures should be done quickly and with a minimum of trauma. Whenever possible one should be content with closing the perforation or covering the defect with omental tissue. The laceration should be sutured in a transverse direction so as to enlarge rather than diminish the size of the bowel lumen. Time-consuming resections are to be shunned and if possible the simple expedient of exteriorization of the affected loops employed. This procedure decompresses the abdomen, removes the damaged segment and permits the patient to recuperate from the peritonitis before instituting reconstructive operations.

Duodenal and jejunal perforations present perplexing problems as the extravasating fluids produce a fulminating peritonitis due largely to their chemical components.

If the rupture is small and situated on the anti-mesenteric border, it can be closed by simple sutures. As a rule, however, the bowel has been crushed against the vertebrae producing so much necrosis that a mere closure is impossible. The injured loops cannot be exteriorized because of their ligamentous and peritoneal fixations, hence, resection or plastic repair become inevitable. When smears of the peritoneal fluids indicate an active bacterial infection, sulfanilamide should be employed immediately.

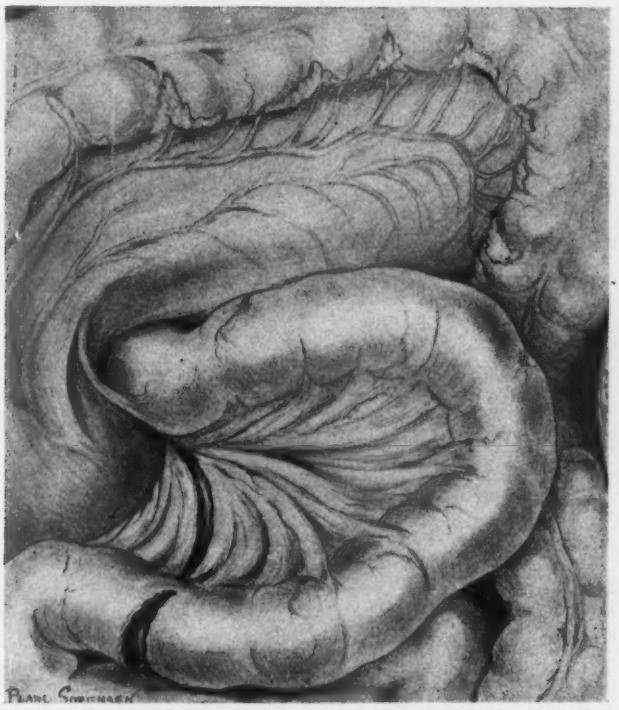

Fig. 4. Lacerations of the jejunum and its mesentery by a blow on the abdomen.

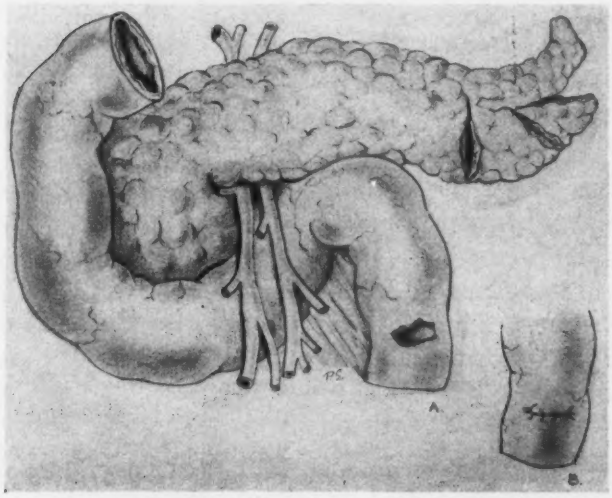

Fig. 5. A, perforation of anterior wall of the jejunum with multiple lacerations of the tail of the pancreas; B, closure of the perforation.

These patients require meticulous postoperative care.[3] The electrolytic and fluid balances must be maintained at the proper

physiologic level. Distention and vomiting can be minimized by the use of the Miller-Abbott tube. Continuous administration of oxygen not only combats any tendency toward anoxemia but greatly reduces the incidence of cardiac and pulmonary infections. Vitamins, particularly vitamin C, should be given parenterally so as to stimulate the healing of the injured mucosal tissues and support the body in its fight against infections. Repeated transfusions with whole blood or its derivatives is an essential part of this program.

Successful therapy is predicated upon an early diagnosis, and prompt and energetic treatment. It is much easier to prevent such complications as peritonitis than it is to control them.

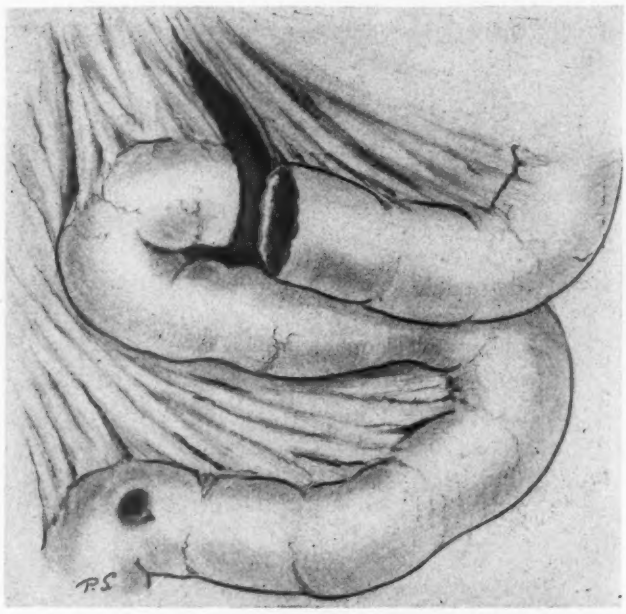

FIG. 6. Complete transverse laceration of the ileum and corresponding mesentery with an associated necrotizing ulcer caused by being struck in the abdomen by a swing.

CASE REPORTS

CASE I. *Delayed Perforation of the Colon Resulting from an Attempted Reduction of an Umbilical Hernia:* A farmer, fifty-six years of age, had a strangulated hernia which, both he and his physician, had unsuccessfully attempted to reduce. An immediate laparotomy demonstrated an incarcerated loop of transverse colon which contained four small subserosal hematomas. As they conformed to the pattern of a clenched fist the hematomas were apparently produced by digital compression during the attempted reduction. The colon seemed viable so it was returned within the abdomen and the hernia was easily repaired. On the tenth postoperative day there was a copious discharge of fecal material from the wound. The second operation revealed that two of the hematomas had slowly necrotized producing a delayed intestinal perforation. (Fig. 2.) The involved segment was resected and a complete recovery resulted.

CASE II. *Delayed Rupture of the Jejunum:* A nine year old boy fell from a high gate in such a manner that he struck his abdomen. After recovering his breath he complained of pain in the right elbow. There were no signs of fractures or internal injuries so he was sent home. Six days after the accident he complained of nausea, vomiting and intense abdominal cramps. An abdominal paracentesis confirmed the diagnosis of a generalized peritonitis from a ruptured viscus. On opening the abdomen intestinal contents could be seen escaping from a traumatic perforation of the jejunum. (Fig. 3.) The small lacerative opening was closed but in spite of adequate drainage, blood transfusions, chemotherapy and oxygen inhalations, he lived but sixteen hours.

CASE III. *Laceration of the Jejunum and Its Mesentery:* A boy, nineteen years of age.

was struck by an automobile. He remained unconscious for twelve hours and then aroused sufficiently to complain of intense abdominal pains. Thirty-six hours elapsed before he was admitted to the hospital where a diagnosis of a ruptured viscus was made. At operation, the terminal jejunum was found to be practically avulsed and its corresponding mesentery badly torn. (Fig. 4.) The severed bowel was re-united and the rent in the mesentery was sutured. In spite of active shock therapy the patient died three hours later from the effects of a fulminating peritonitis.

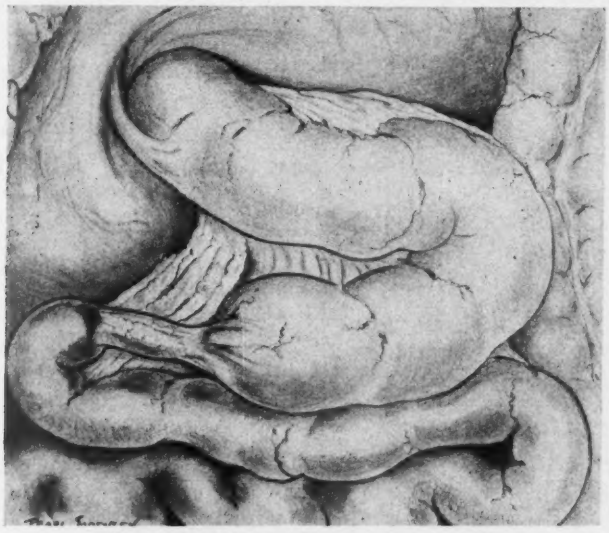

Fig. 7. A blow to the abdomen resulted in chronic intestinal obstruction due to ischemic fibrosis of the ileum and the corresponding mesentery. Note the dilated proximal loop.

Case iv. *Ruptured Ileum and Multiple Lacerations of the Pancreas:* A truck driver was thrown from his cab in such a manner that his abdomen struck a telephone pole and his head bumped the curb. He was rushed to the emergency hospital but relatives refused permission for an exploration until thirty-six hours had elapsed. The jejunum presented a punctate perforation on its anterior wall and the tail of the pancreas contained multiple stellate lacerations. (Fig. 5.) The lesser and greater omental cavities contained intestinal fluids, blood and pus. The jejunal perforation was easily closed by infolding sutures but no attempt was made to suture the pancreas as all bleeding had subsided spontaneously. He lived but eleven hours and autopsy revealed a generalized peritonitis.

Case v. *Immediate and Delayed Ruptures of the Ileum:* A girl, six years of age, was struck in the abdomen by a swing. She was knocked to the ground but immediately jumped up and resumed her play. Approximately twenty-eight hours later she began to complain of abdominal cramps. A laparotomy disclosed a complete transverse laceration of the ileum with a generalized peritonitis. In the presence of the fulminating infection an end-to-end anastomosis was accomplished by means of the Murphy button. Ten days later she developed a fecal fistula and contrast roentgenograms indicated that the sinus tract communicated with the ileum several feet below the site of the Murphy button. Apparently the ileum had been injured in two places, the proximal one represented by the transverse avulsion and the distal one by a crushing injury which required ten days for complete necrosis to take place. (Fig. 6.) She died on the fifteenth postoperative day from peritonitis.

Case vi. *Traumatic Avulsion of the Mesentery with a Benign Stricture of the Jejunum:* A laborer, seventy-five years of age, was struck in the abdomen by a falling plank. He was admitted to the hospital in a state of shock. He complained of nausea, vomiting, hematemesis and melena. Rapid response to therapy suggested a peritonism so he was treated conservatively. The recovery was most rapid. Ten years later he was readmitted because of an acute intestinal obstruction. An exploration revealed a complete fibrous occlusion of the terminal jejunum with a marked

dilatation of the duodenum and jejunum. (Fig. 7.) The regional mesentery was firm, scarred, and avascular. Apparently the old injury had damaged the mesenteric vessels producing the inevitable fibrous constriction of the bowel. The cicatrical segment was resected and his recovery was rapid.

SUMMARY

1. Traumatic perforation of the gastrointestinal tract by non-penetrating forces occur much more frequently than is appreciated. Five such cases are reported.

2. The immediate perforations occur at the time of the accident and are recognized by the accompanying peritonitis.

3. Delayed perforations occurred in 60 per cent of our cases and were not recognized until the inevitable peritonitis appeared.

4. Effective therapy consists in making an early diagnosis, administering energetic shock treatment, and applying corrective measures to repair the damaged bowel.

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It should be noted that the so-called umbilical hernia of adult life does not occur through the umbilicus. It is a protrusion through the linea alba just above the umbilicus or occasionally, just below that structure.

HEPATOCHOLECYSTENTEROSTOMY FOR RELIEF OF JAUNDICE IN OBLITERATION OF THE HEPATIC DUCTS*

R. FRANKLIN CARTER, M.D.
Assistant Clinical Professor of Surgery and Associate Attending Surgeon, New York Post-Graduate Medical School and Hospital, Columbia University

AND

BERNARD MARRAFFINO, M.D.
Junior Assistant Surgeon, New York Post-Graduate Medical School and Hospital, Columbia University

NEW YORK, NEW YORK

RE-ESTABLISHMENT of bile flow to the intestine after extrahepatic bile duct destruction, has provided the surgeon with an interesting and difficult problem. In general, and so long as there has remained any portion of the liver end of the bile ducts, the problem has resolved itself mainly into the use of two sets of procedures: (1) Those designed to reunite the bile ducts and restore a normal channel, and (2) those designed to unite the liver remnant directly to the intestine to form a "by-pass" of the distal remnant and the sphincter of Oddi. The choice of selection of one or the other means of restoration of bile flow is governed chiefly by past experience of the surgeon and the differences in existing conditions found in each individual patient. Seldom does the surgeon find a normal gallbladder and common hepatic bile duct present when the need arises for providing a means of restoration of bile flow to the intestinal canal. In our experience and in that reported by various authors, the gallbladder has usually been destroyed before or along with the destruction taking place in the other parts of the extrahepatic duct system. In a recent instance of this kind, not only was the gallbladder and common hepaticus preserved, but there could not be demonstrated any remaining portion of the liver remnant of the ducts.

Every case presents some inherent differences upon which the selection of the proper surgical procedure depends. The case reported herein was the first instance in which we have attempted to unite the intrahepatic bile ducts to the gallbladder for re-establishing a normal flow and to the intestines for establishing a "by-pass" flow. We believe that the occasion will seldom arise when either of these procedures will have to be employed because of one factor common to most of our cases, viz., that the destruction of the bile ducts is most often associated with the surgical removal of the gallbladder, and that usually there occurs an external bile duct fistula during the course of the development of conditions necessitating an operation for the restoration of bile flow. The gradual suppression of bile excretion through an external bile duct fistula as the fistula opens and closes is accompanied by dilatation of the liver remnant. Dilatation of the liver remnant can be identified at operation as a bile blister in the region of the hepatic fissure. A process of this nature provides a dilated bile sac which can be anastomosed to some part of the intestinal tract. When the obstructive process occurs independent of external bile drainage and is of the type of fibrosing lesion found in our patient, there may never develop the usual bile sac at the hilum of the liver. Under this condition, either or both of the procedures reported herein offers a means of restoration of bile flow into the intestines.

Many questions remain unanswered, chief of which is will such a procedure provide for bile flow from the left lobe of the liver. In this instance we have no direct

* From the Combined Medical and Surgical Clinic for Biliary Tract Disease, New York Post-Graduate Medical School and Hospital (Columbia University).

proof as to that. From the present lack of enlargement of the left lobe of the liver and the relatively low icteric index, we ampulla of the gallbladder, which appeared on macroscopic inspection very much as the tissues in the region of the hepatic ducts

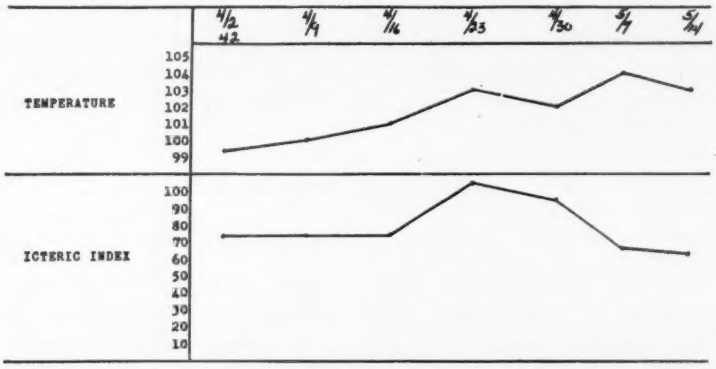
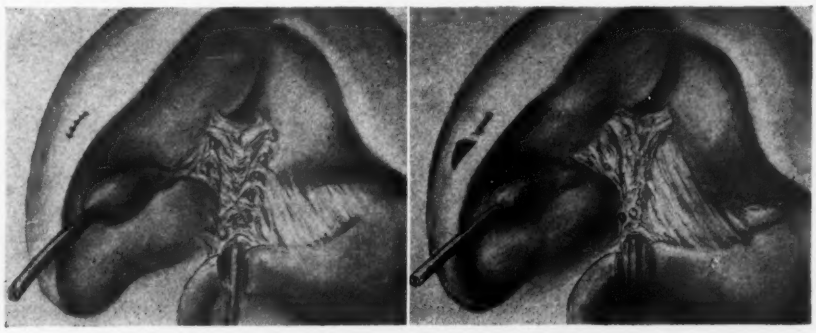
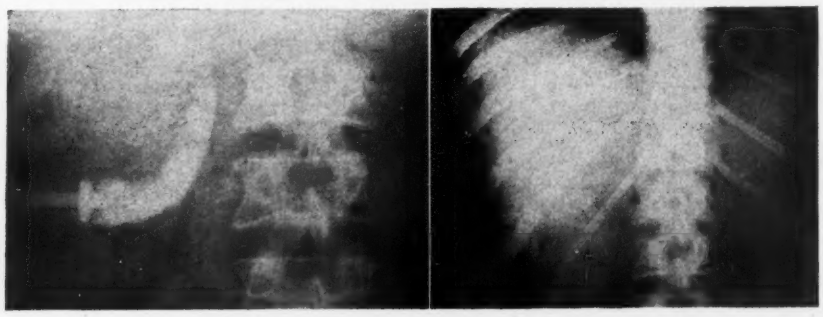


FIG. 1. A, temperature and icteric index curve during the period covering the first two operations.



B C

FIG. 1. B and C, represents condition found at first and second operation.



D E

FIG. 1. D, cholecystocholangiogram showing collapsed gallbladder. E, *x*-ray showing high diaphragm on right side which was thought to be the result of a subphrenic abscess.

believe that this has been accomplished. The exact nature of the fibrosing lesion is also open to much controversial speculation. More comments upon this peculiar tendency for the extrahepatic bile ducts to undergo fibrosis are being heard in discussions of today. One recent case of linitis plastica type of carcinoma of the in this patient, very strongly suggests that process as a possibility to account for the obstructing lesion in this patient. No satisfactory duct tissue offered itself for excision for biopsy study during the exploration of the region at operation (Fig. 1B) at the time when the condition was first considered to be permanent. Prior to this, at

operation (Figs. 1B and 1C), no thought of carcinoma was entertained. Infection was considered as the foremost cause and cultural specimens were considered to be adequate. A lymph node removed from the hepatic duct region at operation on July 21, 1942, three months after onset of jaundice, revealed only chronic inflammatory changes.

CASE REPORT

R. B., a female, age forty-eight was admitted to the New York Post-Graduate Hospital ward service on April 2, 1942. Her chief complaints were right upper abdominal pain of twelve days' duration; intermittent, aching sensation not influenced by taking of food or movements of the body; radiation to right shoulder and back region.

Associated symptoms were nausea but no vomiting. Jaundice was present which had its onset seven days previously and steadily increased. Clay colored stools and very dark urine had developed during those seven days, but there were no fever or chills. There had been a loss of seven pounds, attributed to nausea and lack of appetite. No previous attacks or symptoms of similar nature and no serious diseases or conditions of any relevant nature were reported.

Physical examination revealed the patient to be normal from a nutritional standpoint with deep, dark jaundice and suffering no apparent pain. The abdomen was normal in outline and contour. There was bilateral resistance in the upper half with moderate tenderness. Liver and spleen were not palpable and no gallbladder mass was felt.

The provisional diagnosis was acute cholecystitis with cholelithiasis and common duct obstruction by stone.

On admission the temperature and pulse were normal. Blood examination showed 3.8 red cells and 6.4 white cells; an icteric index of 75 units with a direct Van den Bergh of 4+ and indirect positive; bilirubin 15 mg. per cent; cholesterol total of 375 mg. per cent; esters 215 mg. per cent; blood amylase activity of 2.5 per cent; bleeding time of 2 minutes, coagulation time of 3 minutes. Wassermann test was negative; prothrombin clotting time 93 per cent of normal. Duodenal drainage on the second and third day after admission revealed no bile flow into the duodenum. After antispasmodics on the fifth and sixth days there was still no duodenal bile specimen obtained. Flouroscopic examination confirmed the presence of the tube, from which no bile returned, in the duodenum. The provisional diagnosis of common duct obstruction was confirmed. When the preoperative preparation was completed, the patient was ready for exploration on the sixth day after admission to the hospital.

The preoperative medical care and the subsequent medical care through the periods of obstruction without bile flow, obstruction and external bile flow, and the period of rehabilitation after natural bile flow had been established is worthy of report in detail, a period extending from April 2 to December 30, 1942, if space permitted. Suffice it to say that the surgical measures described as having been carried out in this case cannot possibly be undertaken and executed without the assistance of the most heroic medical measures obtainable today.

First and Second Operation. (Figs. 1A and B.) There is recorded in Figure 1A the average high temperature record during the period comprising the first two operations and up to May 20, 1942. During this period the average weekly high temperature ranged from normal during the week preceding operation to 103° and 104°F. Daily variations were typical of the true septic course seen in infectious cholangitis at the time of the second operation. (Fig. 1C.) Cultural examination of the gallbladder wall and gallbladder bile taken at the first operation gave negative results. Blood cultures taken at the time of the second operation were likewise negative.

The icteric index curve rose from 75 units on admission to 100 units midway between the first and second operation.

The operative findings at the first operation were surprising and confusing. The abdomen contained no fluid; the liver was two finger breadths below the costal margin, surface smooth and glistening and not adherent, color typical for early biliary cirrhosis. The gallbladder was normal in size and color, its walls moderately edematous. A more acute inflammatory process involved the cystic duct, hepatic duct and the tissues immediately in this region. Lymph nodes were enlarged and beefy, blood vessels engorged, and tissues generally edematous and swollen. The foramen

of Winslow was open through which the tissues comprising the gastrohepatic ligament were readily palpable. Lymph node enlargement at the cystic duct angle and from the hilus of the liver extended along the course of bile ducts to the superior border of the duodenum making up the principal of the mass in this region. The hepatic ducts above were not distinguishable separately from the lymph node mass. Below the cystic duct, the common bile duct was discernible and it appeared to be normal in size. No masses suggestive of stones were palpable on bi-manual manipulation through the foramen of Winslow.

The gallbladder was opened and found to contain a small amount of yellow tinged fluid; no stones were present. The interior surface appeared moderately congested and edematous. Probing of the cystic duct was not followed by bile flow into the gallbladder although the duct was demonstrated to be patent and not unduly dilated.

The entire process appeared to be one of acute inflammation involving chiefly the liver portion of the gastrohepatic omentum. The rest of the omentum showed no enlargement of nodes and none were found along the lesser curvature of the stomach. The pancreas and the nodes thereabout did not appear to be involved. No surgical means of draining the bile ducts above the zone of inflammation offered itself. No dissection of the acutely inflamed region above the cystic duct further than careful inspection for the usual bile duct sacculation previously seen in patients with common duct injury, seemed feasible. This could not be found in the mass of acutely inflamed glands and fibrous tissue.

A cholecystostomy tube was placed in the fundus of the gallbladder more or less upon the hope of a subsidence of the acutely inflamed zone and lymph node mass above the cystic duct. With the tube, free bile drainage to the exterior would be assured. Also cholecystocholangiographic studies would be provided for by a cholecystostomy for whatever light might be thrown upon what appeared to be a completely baffling problem to the operator at the moment.

A routine wedge-shaped biopsy of the anterior surface of the liver was taken. No unusual dilatation of the intrahepatic ducts or escape of bile from the wound was noted at this time.

Pathological examination of the liver biopsy and gallbladder wall revealed moderate biliary cirrhosis and mild cholecystitis. Cultural examinations were negative.

Postoperative Course. There was a normal reaction and no immediate temperature rise. Bile drainage from the cholecystostomy tube during the first twenty-four hours was 40 cc. in volume. On microscopic examination an occasional white blood cell, cholesterol crystal and 2+ amorphous substance was found. Chemical examination: Bile salt content, by Rheinhold-Wilson method, 200 mg. per cent; Aldrich-Bledsoe method, 700 mg. per cent; cholesterol, by Lieboff method, 40 mg per cent; pancreatic ferments—amylase, by Myers and Fine method, 15; lipase, by Cherry-Crandall method, negative; protease by Fermi Gelatin method modified by Myers, negative. Bile drainage continued for four days after operation; the volume ranged from 20 to 100 cc. with little change in concentration from that in the first day's output. One week postoperatively, bile drainage ceased altogether, as shown by chemical analysis of the small volume of colorless fluid drained through the cholecystostomy tube. Thereafter and until the second operation there was only an occasional specimen received from the tube in which low concentration of bile elements could be detected, an intermittent drainage of small amounts of bile in a continuous mucous drainage from the gallbladder up until the second operation one month later. The corresponding rise in icteric index from 50 to 104 units during this period indicated the drainage through the cholecystostomy tube and that possibly entering the duodenum to be far below normal.

Cholecystocholangiogram (Fig. 1D) taken by retrograde injection of hippuran following the first operation shows normal filling of the gallbladder and cystic duct with no opaque substance reaching the hepatic and common bile ducts.

The gradually rising and spiking temperature with the appearance of chills after three weeks suggested some complication or an extension of the inflammatory process. Negative operative cultures were confusing especially as the appearance at operation strongly suggested an infectious basis.

An *x*-ray (Fig. 1E) revealed an elevated right diaphragm which, taken with the clinical picture, indicated a possible subphrenic abscess.

Exploration of this region (Fig. 1C) was performed May 8th, one month after the first operation. No abscess of the subphrenic region or of the liver substance could be found. The region of inflammation beneath the hilus of the liver seemed to be completely frozen in a dense mass of fibrous tissue. The liver was further enlarged, more bile stained, and presented an appearance of severe biliary cirrhosis.

The cholecystostomy tube was changed and a second biopsy performed beneath the site of the previous incision.

Pathological examination of the liver tissue revealed pericholangitis and cholangitis. In addition to the previous lesion of obstruction and mild inflammation shown one month earlier, there was evidence of a severe inflammatory reaction around the intrahepatic ducts.

Course Following Second Operation. (Fig. 1A.) Following this operation, there was an appreciable improvement in the temperature and icteric index curves. Bile drainage from the gallbladder tube was negligible and very infrequent. The dressings about the tube began to show evidence of bile drainage, the first indication of drainage of bile from the biopsy wound. This source was not recognized at the time. It was attributed to poor function of the cholecystostomy tube. Irrigation and changing of the cholecystostomy tube was tried but the tube drainage of bile did not return as the dressings became more and more saturated with bile.

Cholecystocholangiography (Fig. 2D) by retrograde injection of hippuran through the cholecystostomy tube revealed a normal gallbladder, cystic duct, common bile duct, pancreatic duct and sphincter of Oddi action. These findings revealed the first indication of improvement in the inflammatory process about the ducts below the cystic union with the common hepaticus in the region of the gastrohepatic ligament.

A more thorough exploration of the region around about the hepatic ducts seemed to be indicated by the *x*-ray. The third operation took place May 20th (Fig. 2B), twelve days after the exploration for subphrenic abscess. The region of the hepatic ducts was exposed and explored by "mousing" into this tissue with sharp, pointed forceps dissection. No structures resembling hepatic ducts could be identified after prolonged search. The tissue in this region resembled sinew developed about any inflammatory process of long standing, viz., a grayish substance of such density that individual structures could not be distinguished as such. Dissection led to blind ends in a region in which exploration was fraught with the possibility of causing irreparable damage to the patient. After splitting the tissues in this region into shreds of nondescript masses, the search for the hepatic sacculation usually found in this region was abandoned.

The original biopsy wounds were exposed, the dome of the liver was found to be free of abscess as before, and a third biopsy performed in this region. No intent to establish external biliary drainage was entertained at this time. The intent of the biopsy was further observation in the course of the development of the stages of biliary cirrhosis.

Course Following the Third Operation. The severe septic clinical picture continued after the operation. Daily spiking temperature of 104° to 106°F. were preceded by chills and followed by exhaustion. (Fig. 2A.) The medical staff persisted in efforts to support the patient generally with a large carbohydrate intake. The vitamin, protein and carbohydrate intake were chiefly supplied by daily intravenous administration. Anemia was treated by frequent blood transfusions. Bile salt therapy by mouth and intravenous administration was resorted to. Following the latter, an increase in bile flow into the abdominal dressings was noted. However, the general condition of the patient seemed to be downhill as she continued to lose weight, run a septic course and show a gradually rising icteric index curve.

Drainage into the dressing and not through the cholecystostomy tube finally attracted sufficient attention to stimulate the attempt to inject the sinus around the tube to determine where the bile flow came from. The *x*-ray (Fig. 2E) shows a catheter inserted into the sinus above the cholecystostomy tube as it passed upward into the substance of the liver. This finally gave us a clue to work with, viz., to provide for an increase in the flow of bile from the intrahepatic ducts which had been inadvertently established through the biopsy wounds.

Fourth Operation. (Fig. 3B.) The cholecystostomy tube was removed and the external bile flow followed down to the point at which it was seen to be coming from the anterior

liver surface at the point of previous biopsies. Probing and dilating this small sinus as the liver substance was entered, a larger intrahepatic sinus was discovered. Into this sinus a No. 16 catheter could be passed for a distance of 12 cm. There flowed from this tube a full stream of amber colored bile containing flakes of fibrin.

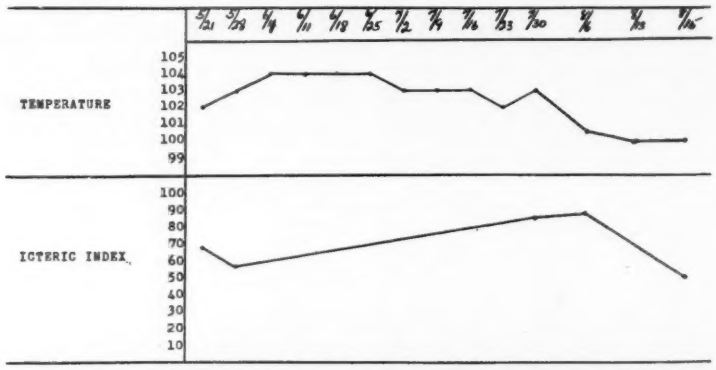
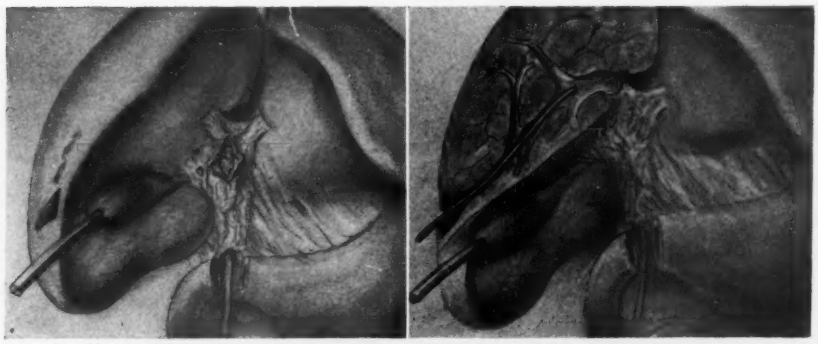
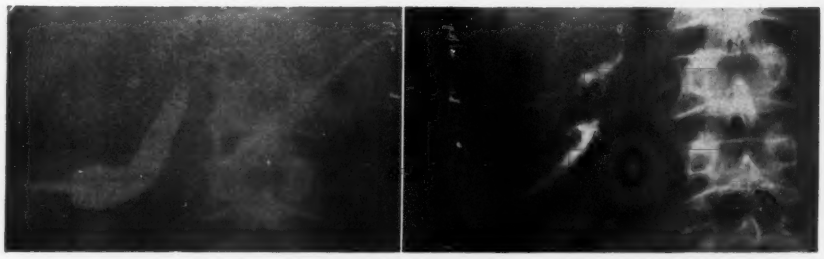


FIG. 2. A, temperature and icteric index curve throughout the course of the procedure from May 21st to August 15th.



B C



D E

FIG. 2. B, exploration of the region of the common hepatic duct above the cystic duct.

FIG. 2. C and E, hippuran injected into the substance of the liver through catheter which passed through abdominal wall into the bile sinus.

FIG. 2. D, cholecystocholangiogram showing gallbladder, cystic duct, common bile duct and pancreatic duct filled with hippuran.

Realizing that we had a serviceable gallbladder, cystic and common ducts present, we resolved to attempt to divert the flow of bile from the intrahepatic ducts into the gallbladder and thence by the normal route into the duodenum. To accomplish this, the undersurface of the gallbladder was incised longitudinally. Through the liver surface of the gallbladder there were made, with a cautery, fine deep puncture wounds. (Fig. 3B.) The sinuses were estimated to be made deep enough to transfix the dilated intrahepatic ducts. As these were made, there was profuse bleeding. To control this hemorrhage, we inserted wooden plugs, blunt ends of orange sticks, with a silk thread attached, by which the sticks could be

removed later through the cholecystostomy opening. The longitudinal incision into the inferior surface of the gallbladder was closed over the base of the sticks thus holding them firmly plugged into the liver punctures. The cholecystostomy tube was not replaced. The catheter in the intrahepatic ducts and the five silk threads were brought out with cigarette drains through the abdominal wound. (Fig. 3C.)

The hepatic duct region was again explored without finding evidence of bile blister or sacculation frequently found in the region of liver fissure in patients having had common duct obstruction. A lymph node was removed from this region for study.

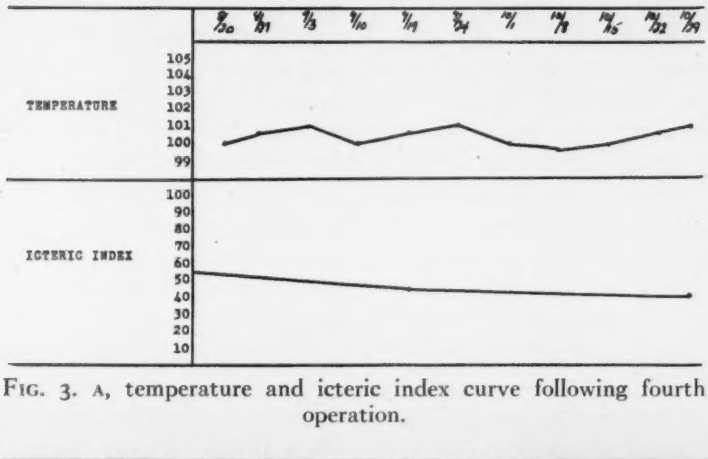
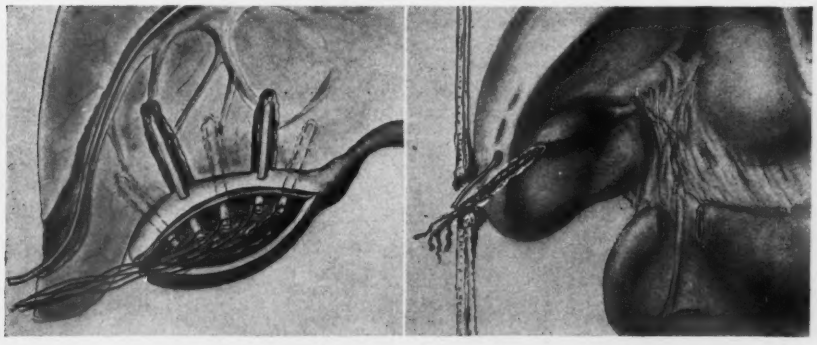
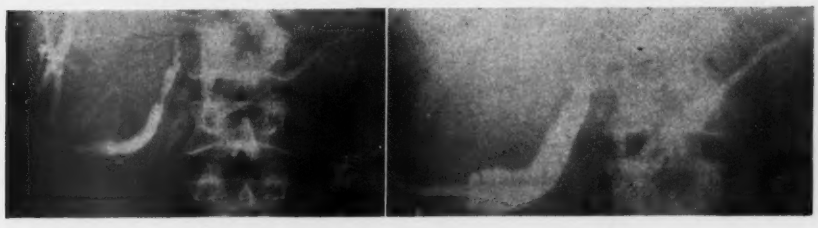


FIG. 3. A, temperature and icteric index curve following fourth operation.



B C

FIG. 3. B, drawing to illustrate the catheter passed into the liver through the bile sinus and means used to connect the intrahepatic bile duct to the gallbladder. C, gallbladder closed, silk threads from gallbladder and catheter in sinus brought out through wound.



D E

FIG. 3. D, injection of the liver sinus and gallbladder reveal dilatation of the intrahepatic duct and their communication from the right lobe of the liver to gallbladder and cystic, common duct and duodenum. E, shows close-up of cholecystocholangiogram done prior to the operation in Figure 3B.

Pathological examination of the lymph node revealed chronic inflammation. Cultures of the bile from the intrahepatic ducts showed, for the first time, gram-negative rods of the coli aerogenous group and Bacillus pyocaneous. Specimens of liver showed an acute and chronic inflammation of the liver with less evidence of biliary obstruction. Cultures of bile

from the intrahepatic duct drainage revealed Bacillus coli.

While the bile obstruction had been partially relieved by the external drainage from the biliary fistula, there remained a severe secondary infection of the liver.

The *x*-ray in Figure 3D shows large intrahepatic ducts in close proximity to the liver surface of the gallbladder into which we presumably carried the cautery incisions.

Course Following the Fourth Operation. (Fig. 3A.) As can be seen by the temperature curve, the septic condition began to respond soon after better drainage of the liver had been established. Liver damage was severe as is shown by the continued high icteric index curve. Chemical blood examination revealed an icterus index of 83 units, Van den Bergh direct 4+, indirect 8 mg. per cent; total cholesterol of 165 mg. per cent; esters of 60 mg. per cent, a ratio of 36 per cent; an indication of considerable liver damage remaining although an improvement over the low of 30 per cent esters at the time of the third operation. The white blood count dropped from 24,000 at the time of the third operation to 14,000 in one week's time. The chills disappeared, vomiting ceased and although the patient continued to run a temperature of 101° to 102°F., the spikes disappeared as the drainage from the intrahepatic duct tubes cleared up.

The silk threads with plugs attached were withdrawn from the gallbladder through the cholecystostomy opening sixteen days after operation. The intrahepatic duct catheter continued to drain more bile of better quality from day to day. Chemical analysis showed variation and a low bile salt and cholesterol concentration.

Shortly after the withdrawal of the wooden plugs, the dressing began to be saturated by bile flow. At the same time, the intrahepatic catheter drainage was discharging into a bottle by the side of the patient. Examination of the gallbladder sinus showed a slow trickle of amber colored bile to be coming from the cholecystostomy opening.

The general condition of the patient showed definite improvement in so far as sepsis was concerned. She was out of bed but very weak and emaciated. On August 15, 1942, she was discharged to the Gallbladder Out-Patient Clinic for observation and treatment, by the medical staff, for liver damage and replacement therapy resulting from external bile drainage.

Course during Observation and Treatment in the Out-Patient Gallbladder Clinic. There was a gradual decline in temperature and icteric index curves. Vomiting ceased and appetite improved. Some gain in strength and weight occurred. External flow of bile through the sinus from the intrahepatic ducts and that flowing from the sinus established between the gallbladder and intrahepatic ducts continued. So far as could be discerned, the majority of bile flow was external. The stools were light colored during this period. The urine discoloration cleared up. The icteric index curve came down to 40 units where it leveled off and became stationary.

The medical therapy during this period consisted mainly of a daily carbohydrate intake of from 400 to 500 Gm., 75 Gm. protein and little fat. Vitamins A, B complex, and D were given by mouth. Bile salts in 1 Gm. daily dose was administered. Iron and liver in capsule form was administered throughout this period.

There was never any indication of failing pancreatic digestion. Throughout the whole course, the blood pancreatic ferments were normal. No intestinal distention or steatorrhea occurred at any period.

Final Operation to Convert External Bile Flow into Intestines. By November 3, 1942, and approximately seven months after the onset of disease, the patient was adjudged to have reached the point in general recovery and rehabilitation in presence of external bile drainage at which surgical restoration of internal bile flow could safely be attempted. At this time the daily temperature curve did not exceed 100°F. The icteric index curve was fixed at about 40 units. General strength and stamina were below normal but very much improved over that at discharge on August 15th.

Second Admission—November 3, 1942. The temperature course on admission and during a week's observation did not exceed 100°F. (Fig. 4A.) The blood chemical examination revealed an improvement in liver function—icteric index 34 units; cholesterol total 168 mg. per cent; esters 85 mg. per cent, a ratio of 51 per cent; bromsulphalein test 12 per cent at thirty minutes and 8 per cent at sixty minutes. Blood count revealed red cells of 3.23, hemoglobin 51 per cent and 15,500 white blood cells. Abdominal examination showed no signs of acute infectious process. The liver and spleen are not palpable.

Bile flow from the abdominal sinus was continuous and not attended by digestion and excoriation of the abdominal wall. A wooden plug was strapped with adhesive across the opening in the skin with an immediate obstructive reaction of discomfort, nausea and vomiting accompanied by a slight temperature rise. Following this experience, the surgical staff gave up all hope of the external biliary fistula closing spontaneously. Operative closure was deemed to be necessary.

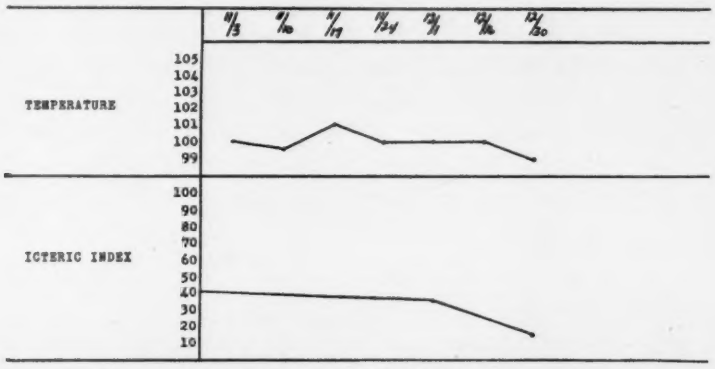


Fig. 4. A, clinical course following final operation.

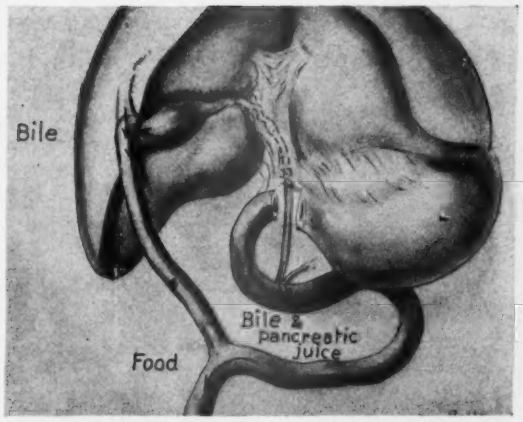


Fig. 4. B, the arrangement of the intrahepatic bile duct and fundus of the gallbladder union to the intestine after the final procedure.

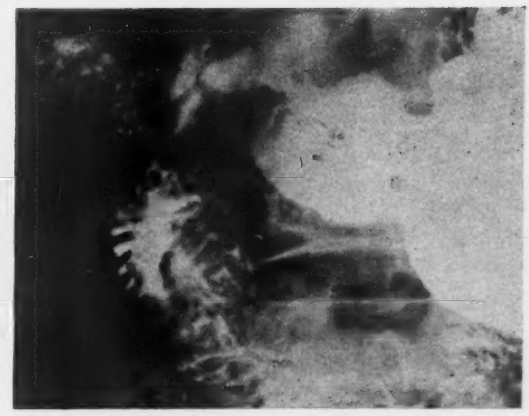


Fig. 4. C, visualization with barium meal of jejunal intestinal loop leading up to the bile sinus of the intrahepatic duct and gallbladder.

The patient was prepared by blood transfusion and forced intravenous therapy to undergo operation.

Final Operation. (Fig. 4A and Fig. 4B.) On November 12, 1942, about seven and one-half months after the onset of illness and during a period in which there had been little or no normal bile flow into the intestinal tract, operation for restoration of this flow was undertaken. The abdominal incision presented two small openings in the outer angle of a paracostal type of incision. One of these sinuses led into the gallbladder and the other into the intrahepatic duct system of the right lobe of the liver. They were separated by a portion of normal skin 1 cm. in width.

An approach to the problem of anastomosing these two openings to the intestinal tract was begun by making an incision circumscribing both openings and leaving a margin of skin 1 cm. in breadth on all sides. The remainder of the paracostal incision was opened along the pre-existing scar line. The circumscribing incision was carried down and through all the layers of the abdominal wall. The paracostal incision likewise was opened up completely exposing the right upper quadrant of the abdomen. The button of tissue containing the two sinus openings and made up of the abdominal wall was left adherent to the anterior surface of the right lobe of the liver and fundus of the gallbladder. The two sinuses through the button of tissue lead into the gallbladder and intrahepatic ducts, respectively.

No attempt was made to explore the seat of the former inflammatory zone in the hepatic duct region. The stomach appeared to be

normal. Around the hepatic flexure of the colon the upper jejunum was identified and brought up into the abdominal wound. The gut was clamped and cut transversely. Incision into the mesentery was carried back to its base far enough to allow for carrying the distal cut end of the gut up to the button of tissue containing the two external bile fistula openings.

An anastomosis between the open distal jejunal end and the skin button was carried out by approximating catgut sutures including the skin margin of the button and the open end of the distal segment of jejunum. Reenforcing sutures of interrupted silk were placed around the union of the skin button and jejunal anastomosis. (Fig. 4B.)

The proximal end of the severed jejunum was anastomosed to a longitudinal incision into the side of the jejunum at a convenient level. The opening in the jejunal mesentery then was closed. (Fig. 4B.)

Postoperative Course to Date. Within an hour following the last operation, the patient vomited bile stained fluid. The first definite indication of bile flow into the intestine in almost eight months. The postoperative course was normal. There was no leakage of jejunal fluid from the wound. The wound healed by primary intention. The patient was discharged back to the Gallbladder Clinic on the fourteenth postoperative day.

The stools began to show evidence of bile content soon after the last operation. The patient's appetite and general strength improved. Gradually the administration of bile salt and vitamins were withdrawn as the general dietary intake increased. Iron and liver extract have been continued during the period since last operation.

To date and four months following last operation, the patient's general health is fair. There has been a gain in weight of fourteen pounds. The stools are normal in color. The icteric index is 15 units. Abdominal examination shows no spleen or liver enlargement. Duodenal drainage attempted one month after operation did not result in recovery of bile from the duodenum as the tube was shown by fluoroscopy not to enter the duodenum. While we do not have any direct evidence of the establishment of a normal flow of bile from the gallbladder to the duodenum on the basis of the operation to connect the intrahepatic duct mucous membrane to the gallbladder mucous membrane by growth along the sinuses made by cautery, we believe that such a system probably exists from the appearance of bile drainage from the cholecystostomy wound, vomiting of bile postoperatively and the preoperative *x*-rays showing this tract to be open below the gallbladder.

X-rays (Fig. 4C) taken two and a half months following the last operation, following barium meal by mouth, show the intestinal loop leading up to the bile sinus and fundus of the gallbladder to be functioning. No barium is seen to enter the gallbladder or intrahepatic ducts.

COMMENT

It is on the belief that we have established mucous membrane union to mucous membrane, intrahepatic duct to gallbladder, that we hope for permanent relief in this patient. The sinus leading from the intrahepatic ducts and from the fundus of the gallbladder will, we believe, close in time due to the contracture of the fibrous tissue in its wall. The latter assumption is based upon results in our experience with the formation of a false tract "Sullivan Procedure" to anastomose the two ends of the intrahepatic ducts. We have come to believe that all procedures in this field should have as their prime object for permanent success, the union of intestine to bile duct and an approximation of all the layers of both without the interventoin of any foreign substance whatsoever.

EVALUATION OF SULFONAMIDES IN THE TREATMENT OF PERITONITIS OF APPENDICEAL ORIGIN*

A REVIEW OF 903 CASES OF ACUTE PERFORATIVE APPENDICITIS

C. E. STAFFORD, M.D., JOHN BESWICK, M.D. AND PAUL H. DEEB, M.D.
Attending Surgeon, Los Angeles County General Hospital
LOS ANGELES, CALIFORNIA

OF the approximate 30,000 deaths which occur each year in the United States from peritonitis, nearly two-thirds are a result of acute appendicitis with perforation. This high mortality offers a constant challenge to every surgeon to find a treatment of peritonitis which will reduce these figures. During the decade prior to 1940, in various sections of the country, some progress was made in lowering the mortality. The apparent factors responsible for this improvement were adequate restoration of fluid and chemical balance, decompression of the gastrointestinal tract, a more direct approach to the appendix, and the proper indications for surgical intervention.

In 1940, Stafford and Sprong reported a mortality of 10 per cent in a series of 479 cases of perforated appendicitis with either abscess or peritonitis treated by immediate surgery. In a series of cases reported by Barrow and Ochsner in which appendiceal peritonitis was treated both by immediate surgery and conservative measures, the mortality was 27.3 per cent.

With the advent of sulfanilamide, an additional weapon for combatting peritonitis was recognized. The use of this drug in the treatment of appendiceal peritonitis was begun in 1936, and in 1940 Ravdin, Rhoads, and Lockwood demonstrated that sulfanilamide could be recovered from the peritoneal cavity as well as from the blood when given subcutaneously. The first report of the intraperitoneal use of sulfanilamide for peritonitis of appendiceal origin was made in 1940 by Dees of Memphis, Tennessee. This favorable report was quickly followed by considerable experimental as well as clinical evidence of the value of sulfonamides used intraperitoneally for controlling the peritoneal invasion of organisms particularly in the preperitonitis stage.

Thompson, Brabson, and Walker reported fifty-nine cases of severe acute appendicitis without a fatality in which intra-abdominal sulfonamides were used. A very recent report of Walter and Cole showed the therapeutic value of intraperitoneal sulfadiazine both for the treatment and prevention of peritonitis.

ANALYSIS OF CASES

However, in the numerous clinical reports available there are no large series of appendiceal peritonitis cases showing mortality rates over a period of several years and compared with the mortality of years previous to the use of sulfonamide therapy. In order to obtain these comparative mortality figures, a careful survey was made at the Los Angeles County General Hospital of 903 consecutive cases of acute appendicitis with perforation or abscess formation. This study included a four-year period from 1939 to 1942 beginning with the year in which sulfonamides were first used parenterally and the following three years in which sulfonamides were used with increasing frequency both parenterally and intraperitoneally.

Mortality. During the three years previous to 1939 the mortality rate for perforated appendicitis had shown some

* From the Department of Surgery, College of Medical Evangelists, Los Angeles General Hospital.

decrease and was attributed as previously mentioned to better surgical judgment, a more careful attention to chemical and fluid balance, the routine use of gastro-intestinal decompression, and the use of the McBurney incision. As shown in Figure 1 the mortality has gradually decreased from 9.2 per cent in 1939 to 3.4 per cent in 1942. It would seem that from as large a series of cases as presented here, that definite clinical observations could be made in evaluating the effectiveness of sulfonamide chemotherapy in peritonitis.

Chemotherapy - Perforative Appendicitis

903 Cases - L.A.G.H.

Year	Intraperitoneal Sulfonamides	Intraperitoneal and Parenteral	Mortality Percentage
1939	0	12%	9.2
1940	13%	58%	7.1
1941	78%	85%	5.7
1942	98%	98%	3.4

Fig. 1.

Age and Sex. An interesting observation, made in this group, was that the incidence of perforated appendicitis reached its peak between the ages of eleven to twenty, almost one-third of the cases occurring in the second decade of life. The mortality rate reached the lowest point in the third decade of life almost coinciding with the age group containing the greatest incidence of disease. The ages of these patients ranged from the youngest of eighteen months to the oldest patient of eighty-seven years; and as shown in Figure 2, the mortality increased toward both extremes of life although it was twice as high during the latter decades, as compared with the first ten years of life.

The disease occurred more than twice as frequently in males as females. These figures both for age and sex incidence parallel quite closely other series of cases for acute appendicitis in general which have been reported throughout the country.

Duration of Symptoms. The duration of symptoms of appendicitis before perforation occurred was measured in terms of onset of complaint to the time of operation when a perforation was discovered. This group of 789 excludes cases of perforation with abscess which were drained without appendectomy, as they gave a long and many times indefinite history previous to surgery. Over 8 per cent of these patients gave evidence of a perforation within twelve hours of the onset of symptoms. The highest incidence of perforation occurred between thirty-six to forty-eight hours with more than two-thirds of all the cases occurring within forty-eight hours of the onset of symptoms. There were very few cases with perforation after seventy-two hours. (Fig. 3.)

Type of Operation. All of the 903 patients in this series were operated upon and the diagnosis of perforative appendicitis verified at the time of surgery. Patients with appendicitis not operated upon were omitted from this series in order to eliminate any inaccuracy of diagnosis; also these cases gave no opportunity to observe

the effect of sulfonamides applied in the peritoneal cavity. Non-operative therapy was used only in terminal cases of general peritonitis, or in cases in which a very definite localized mass was palpated in the abdomen. Appendectomy was performed in 789 cases and in the remainder simple incision and drainage of an abscess was done. In 1939, the mortality of the cases drained was 26 per cent as compared with no deaths in this group during 1942. The decrease in mortality in the appendectomy group was not as marked but showed a steady decrease during the four years as illustrated in Figure 4.

One hundred seventy-four cases, or about one-fifth of all the perforations were associated with some degree of abscess formation. The abscess cases receiving operative intervention were those in which no definite mass was palpable preoperatively or the group of cases in which an abscess continued to increase in size in spite of conservative treatment. During 1939, appendectomy was done in approximately one-fourth of the abscess cases and the remainder were drained with a resulting mortality of 21 per cent for all the abscess cases during the year. A comparison is made (Fig. 5) with the year 1942 during which over three-fourths of the abscess cases had appendectomy with no

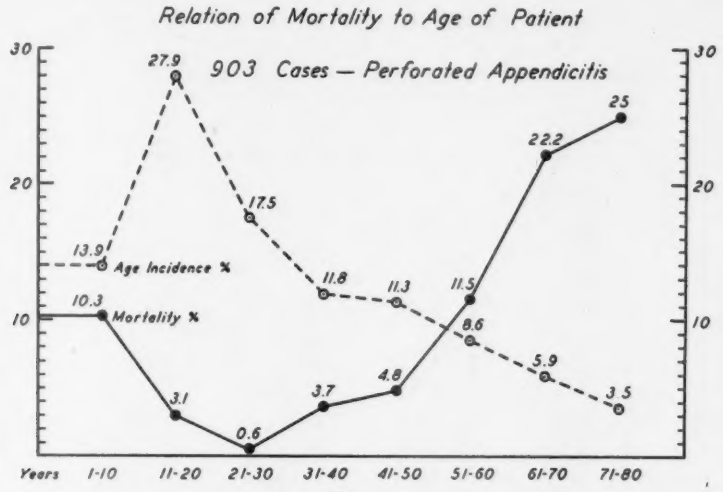


FIG. 2.

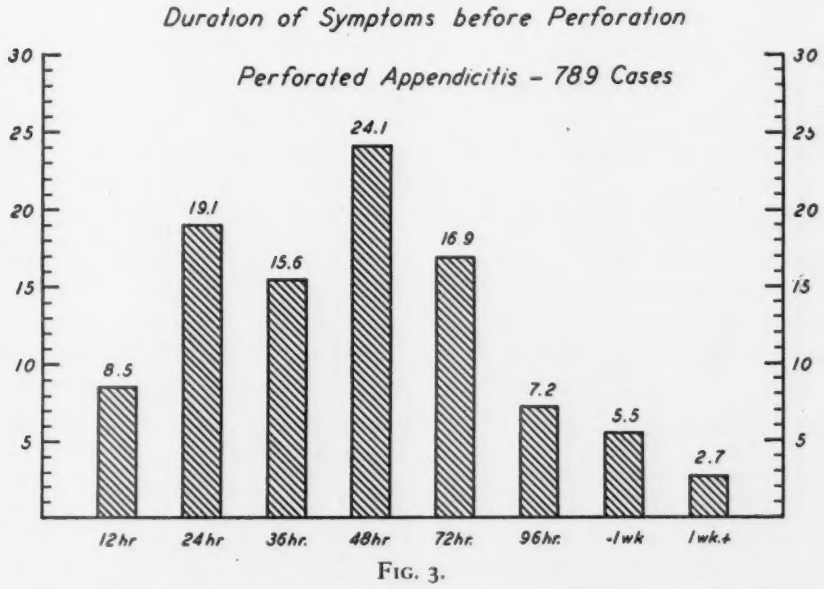


FIG. 3.

deaths. The procedure of incision and drainage without appendectomy was used only in those cases with a completely walled

portant trend is noted in the decreasing tendency of the surgeon to drain the peritoneal cavity in the presence of peritonitis.

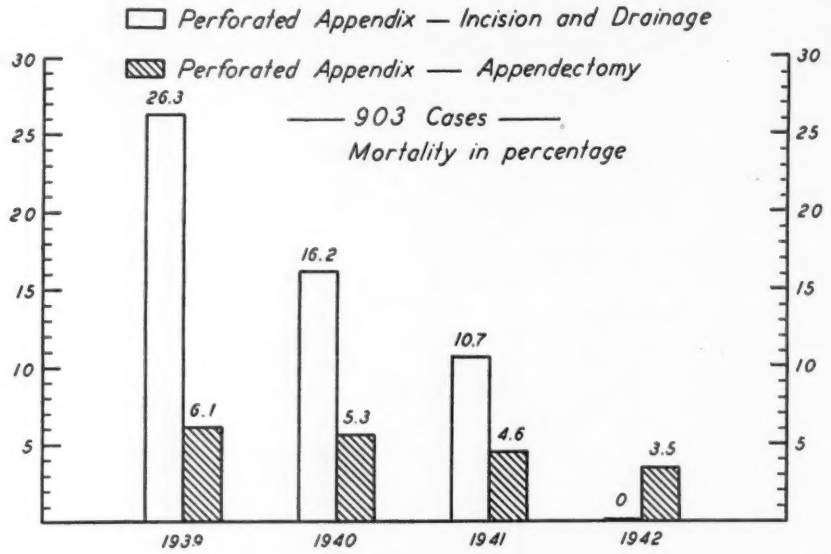


Fig. 4.

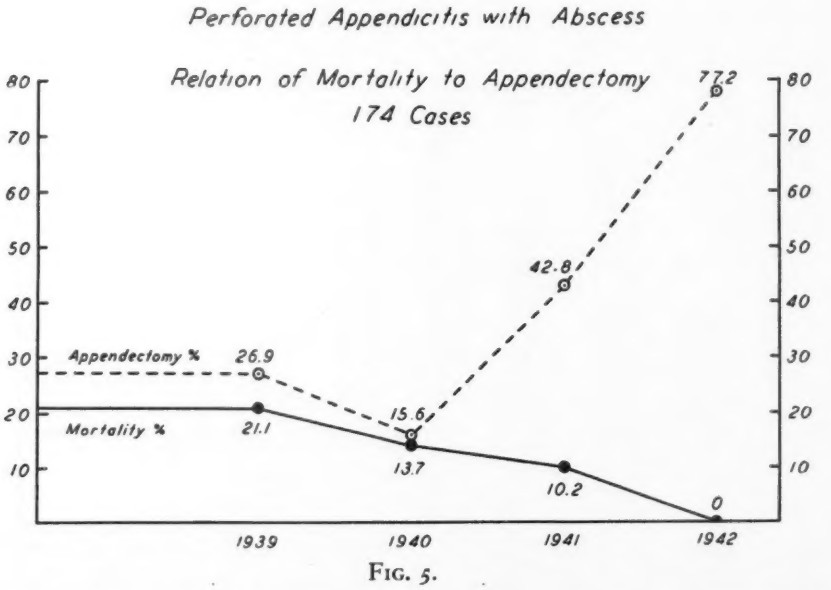


Fig. 5.

off abscess entirely free from the general peritoneal cavity and approached whenever possible through an extraperitoneal route. During the entire four-year period, about one-third of the abscess cases had appendectomy. These figures show an increasing tendency toward the removal of the appendix whenever possible. The decreasing mortality attendant with this procedure would warrant its use.

Drainage of Peritoneal Cavity. An im-

It has long been a known fact, as shown by Yates in 1905, that the drainage of the general peritoneal cavity is physically and physiologically impossible. Many of the surgeons have continued, however, to use drainage for local or spreading peritonitis and to follow the dictum, "when in doubt, drain." The advent of sulfonamides used intraperitoneally has given the surgeon courage to leave out the drain with greater frequency. In 1939, over 90 per cent of

the cases were drained with one or more penrose drains, whereas in 1942 (Fig. 6) about one-third of the patients had no

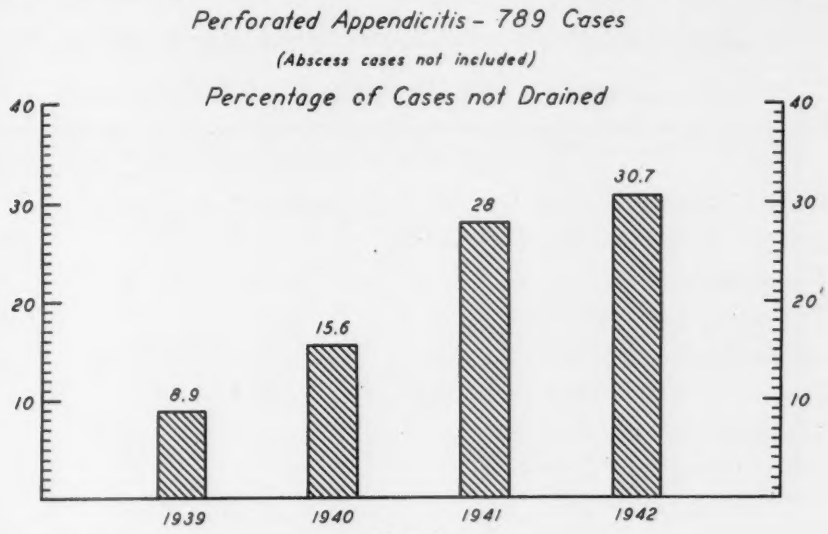


Fig. 6.

drains at all and in many more the drain in the wound extended only to the peritoneum in order to handle any secondary infection in the subcutaneous tissue, which is less resistant to infective organisms than the defense mechanism of the peritoneum.

Sulfonamide Chemotherapy. Sulfanilamide in 0.8 per cent solution was used subcutaneously in a few of the cases during 1939, but none locally in the peritoneal cavity. The following year over half of the cases received sulfonamide therapy of some type, either sulfanilamide solution subcutaneously or 5 per cent sulfapyridine intravenously and a few cases had intraperitoneal sulfanilamide. During 1942, only three cases did not receive any form of sulfonamide chemotherapy and one case received only parenteral therapy. The remainder all received intraperitoneal sulfonamides and two-thirds of these also were treated with parenteral sulfonamide, these being almost entirely 5 per cent sulfathiazole by vein. The intravenous therapy was usually given in 2 Gm. doses every eight hours beginning twenty-four hours after surgery and continuing until a total dose of about 20 Gm. was given. The technic of using sulfonamide intraperitoneally when first applied was to sprinkle one ounce of sulfanilamide powder into the peritoneal cavity at the site of perforation and over the surrounding structures. Subsequently, the crystaline form was found to be better absorbed than the powder and with less foreign body reaction. The dosage of drug used varied from 5 to 15 Gm., but an average of 8 to 10 Gm. was the usual amount implanted in the peritoneal cavity, and 1 to 2 Gm. frequently sprinkled in the abdominal wound. Absorption of the drug by the peritoneum has been shown to be very rapid by Jackson and Coller, who carried out their studies both on patients and on dogs. A 10 Gm. dose of sulfanilamide given intraperitoneally will usually produce a peak blood level of approximately 10 mg. per 100 cc. within two to three hours, which falls off gradually to low levels at the end of twenty-four hours. The local peritoneal concentration of the drug may be a hundred times or more the level reached in the circulating blood.

Sulfanilamide versus Sulfathiazole. Following the experimental study of Throckmorton in 1941 on the peritoneal response to sulfathiazole, this sulfonamide was used frequently in place of sulfanilamide. Epps, Ley and Howard, and Pearl and Rickles have also shown that the local application of sulfathiazole has certain advantages over the other sulfonamide compounds:

(1) It is active against a variety of organisms; (2) it is innocuous to the peritoneum while at the same time stimulating the local cytologic defense mechanism; and (3) it exerts a prolonged bacteriostatic effect. During the year 1942, sulfathiazole was used intraperitoneally in one-third of the cases, the microcrystals being preferable to the powdered drug in that it caused less caking. Sodium sulfathiazole was not used intraperitoneally as recommended by Fox because of the excessive alkalinity of the sodium salt solution resulting in tissue irritation.

Toxic Effects. No deaths in this series of cases could be attributed to the toxic effects of sulfonamide therapy. Hematuria occurred in three cases, twice in patients using sulfapyridine parenterally and once with the use of sulfathiazole. The intraperitoneal use of either sulfanilamide or sulfathiazole apparently produced no more toxic effects than would be expected by the oral or parenteral use of the drugs. Three cases of jaundice were noted following the use of sulfanilamide, but all cleared rapidly after discontinuing the parenteral use of the drug. The importance of possible liver damage in these cases must not be overlooked, but no evidence of permanent hepatic injury was found in this series.

Analysis of Causes of Mortality. The most common causes of death from perforated appendicitis are peritonitis and pneumonitis. The term pneumonitis as used here includes postoperative atelectasis, bronchopneumonia, and lobar pneumonia. As shown in Figure 7 both peritonitis and pneumonitis in the same patient were frequent causes of death. Autopsies were performed in over one-half of the deaths so that the causes of death were diagnosed with accuracy. The results of sulfonamide treatment are indicated in a decrease in peritonitis, and a marked decrease in pneumonitis following the use of sulfapyridine and sulfathiazole. The one case with jaundice at the time of death had received no sulfonamides during the hospital stay. The five deaths during 1942 were all poor risk cases, two of them being over sixty years of age and other three had been delayed after perforation for a number of hours before surgery.

Morbidity. The postoperative morbidity is almost as important an indication of the success of surgical therapy as the mortality. In these cases, the most common

Analysis of Death - Perforated Appendicitis
903 Cases - 61 Deaths - 36 Autopsies

	1939	1940	1941	1942	Total
Diffuse Peritonitis	11	6	5	4	26
Diffuse Peritonitis and Pneumonitis	7	8	3		18
Pneumonitis	2	1	1		4
Pulmonary Embolism	1	1	1		3
Coronary Thrombosis		1	2		3
Pulmonary Tuberculosis (advanced)		1	1		2
Congestive Heart Failure	1				1
P.O. Hemorrhage (Jaundice)		1			1
P.O. Shock				1	1
Lung Abscess	1				1
Cerebral Embolism			1		1

Fig. 7.

complications of perforative appendicitis, namely, pneumonitis and abscess, are summarized in Figure 8. The use of sulfanilamide, either intraperitoneally or parenterally, had practically no effect on the incidence of postoperative pneumonitis, but the use of the more recent sulfonamides has shown a marked effect in decreasing this complication.

Morbidity - Perforative Appendicitis

903 Cases - L.A.G.H.

Year	Pneumonitis	Pelvic Abscess	Subphrenic
1939	16	35	3
1940	17	22	1
1941	6	21	3
1942	2	9	2

FIG. 8.

Mortality - Perforated Appendicitis

903 Cases - L.A.G.H.

Year	Cases	Deaths	Mortality %
1939	250	23	9.2
1940	266	19	7.1
1941	242	14	5.7
1942	145	5	3.4

FIG. 9.

The abscesses following the peritonitis of perforation, localize most frequently in the pelvis although subphrenic abscesses are by no means uncommon. The incidence of postoperative pelvic abscess was apparently decreased by the use of intraperitoneal sulfonamides, whereas the occurrence of abscesses of the upper abdomen beneath the diaphragm was practically unaffected. An interesting observation made was that only about one-half of all the abscesses required surgical drainage, the others either drained spontaneously or subsided by resolution and absorption.

COMMENT

This analysis of cases has been presented with the full realization of the difficulty in evaluating any therapy on the basis of statistical information. Inasmuch, as the experimental background for this therapy has been so thoroughly covered in recent literature, it was believed that a further

presentation of clinical material to cover a large number of cases on a general hospital rather than any small group of selected cases would be of definite value.

A further criticism is also realized in view of the yearly decrease in mortality of acute appendicitis at the Los Angeles General Hospital in the past, it might be expected that the present decrease in mortality would continue without the use of sulfonamide therapy. Also a question that arises is, would not the same results be achieved by the use of parenteral sulfonamides alone without the use of intraperitoneal implantation?

The comparison of mortality decrease with the use of sulfonamides (Fig. 9) appears to be more than coincidental and would seem to indicate a direct relationship between the increased use of sulfonamide therapy particularly the intraperitoneal use of the drug and the consistent decrease in mortality during the past four years.

SUMMARY

A study was made of 903 cases of perforative appendicitis at the Los Angeles General Hospital, in order to evaluate the use of sulfonamides in the treatment of peritonitis.

During the five-year period 1939 to 1940, the mortality rate for perforated appendicitis decreased from 9.2 to 3.4 per cent.

Sulfonamides were used with increasing frequency so that 98 per cent of all the cases during 1942 received some form of chemotherapy. The mortality rate decreased each year as the use of sulfonamides increased.

Morbidity as well as mortality was reduced as observed by the yearly decrease in the frequency of postoperative peritoneal abscesses and pneumonitis.

Drainage of the peritoneal cavity following appendectomy was used less often, as sulfonamides were used intraperitoneally in nearly all cases. In 1942, one patient out of three had no drain used, either in the peritoneal cavity or abdominal wound.

In abscess formation following appendiceal perforation the procedure of choice was incision and drainage only in the completely walled off abscess. In 1942, appendectomy was performed in over three-fourths of the abscess cases without fatality.

Clinical observations on a large group of cases apparently confirm the experimental evidence that sulfonamides are an effective form of therapy in the treatment of peritonitis. Their use is of particular value when implanted intraperitoneally during the early stages of peritonitis in perforative appendicitis.

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KIDNEY SURGERY*

REVIEW OF CASES AT THE SOUTHERN PACIFIC GENERAL HOSPITAL FROM 1930 TO 1943

CHARLES PIERRE MATHÉ, M.D.
Urologist in Chief, Southern Pacific General Hospital

AND

MANUEL JESUS DE CASTILLO, M.D.
Resident in Urology, Southern Pacific General Hospital

SAN FRANCISCO, CALIFORNIA

THIS paper consists of a statistical review of kidney operations performed in the Southern Pacific General Hospital from 1930 to 1943. Through the co-operation of the Departments of Roentgenology and Pathology as well as that of the medical, surgical and house staffs, pathological diseases residing in the remote and deep-seated organs such as the kidney have been brought to light. During the past thirteen years, it has been our object to detect surgical conditions of the kidney early before advanced infection or total destruction has set in. When it is possible to investigate these cases in their preliminary stages, the surgical intervention which would eventually become inevitable may sometimes be averted, and the likelihood of obtaining relief by conservative measures is enhanced.

It has been justly stated that the diagnosis of diseases of the kidney is the most precise in medical practice. Equipped with this tremendous advantage, urologic surgeons are still confronted with the problem of how best to benefit the patient with established kidney disease. Keen evaluation of the individual case coupled with sound surgical judgment based on wide experience and technical ability is our only present basis for determining the most expedient procedure for the individual case. Nephrectomy is a comparatively simple and sure method of obtaining clinical cure, and is the only choice in some cases. In others, however, nephrectomy needlessly sacrifices an organ containing an effective amount of functioning tissue. Conservative renal surgery is both offensive and defensive in action. Its timely application serves to prevent destruction of the kidney as well as to preserve healthy renal tissue. In cases in which it is deemed justifiable to allow the sound portion of the kidney to remain, the patient is left furnished with a reserve which will enable him to combat more vigorously any subsequent urological emergency. Moreover, should reparative surgery prove inadequate, or should one or the other kidney later become the seat of disease requiring nephrectomy, the radical operation can still be performed.

Our goal has been restoration insofar as possible of normal renal physiology, the merits of which have not always been sufficiently appreciated. There is no gainsaying that to do so often taxes the resourcefulness as well as the discernment and skill of even the most experienced conservative surgeon. Although it is believed by some that compensatory hypertrophy of the acquired single kidney establishes the necessary renal counterbalance, hypertrophy of the contralateral kidney has been proved not to occur in partial nephrectomy, the remaining portion of the resected organ (which does not atrophy) carrying on adequately in its intended physiological manner. A long list of patients relieved of suffering and disability is an impressive testimonial to the efficacy of conservative interventions on the kidney. In this report we have reviewed the lesions for which radical and conservative surgery were performed. We have made this analysis with the aim of bettering our surgical judgment, improving our technic and reducing our already low mortality which compares

* From the Department of Urology, The Southern Pacific General Hospital, San Francisco, California.

favorably with that of leading urological services of the country.

Between January 1, 1930, and July 1, 1943, 643 surgical interventions on the kidney were performed at The Southern Pacific General Hospital. Of these, 112 were radical and 531 conservative. (Table 1.)

TABLE 1
CLASSIFICATION OF OPERATIONS ON THE KIDNEY

Nephrectomy		
Renal tumor	17	
Tuberculosis	15	
Hydronephrosis (with stone, 6)	22	
Pyonephrosis (with stone, 4; with cyst, 1)	22	
Pyohydronephrosis (with stone, 2)	6	
Pyelonephritis (sclerozing, 4; with stone, 5)	9	
Nephrolithiasis	5	
Adrenal tumor	1	
Ruptured kidney and ureter	2	
Aneurysm of renal artery	2	
		101
Nephroureterectomy		
Hydronephrosis with ureteritis cystica	2	
Carcinoma of kidney pelvis and ureter	2	
Primary carcinoma of ureter with hydronephrosis	2	
Hydronephrosis with ureteral calculus	4	
Pyohydronephrosis with hydroureter	1	
		11
Conservative Kidney Operations		
Nephropexy	92	
Nephrolysis	92	
Ureterolysis	92	
Renal sympathectomy	94	
Nephrolithotomy	34	
Pyelolithotomy	33	
Drainage of perinephritic abscess	18	
Drainage of kidney abscess	6	
Plastic operations on ureteropelvic junction	14	
Renal resection (for biopsy, 1)	11	
Removal of aberrant renal vessel	13	
Nephrostomy drainage (calculus pyonephrosis, etc.)	21	
Excision of kidney cyst	3	
Decapsulation of kidney	3	
Curettage of kidney sinus	2	
Débridement of kidney sinus	2	
Detorsion of kidney pedicle	1	
		531
Total		643

Mortality. The mortality for all kidney operations reported in this series was 2.2 per cent. In 112 nephrectomies there were eight deaths, or a mortality of 7.1 per cent. The causes of death were: metastasizing kidney cancer (two); coronary occlusion (two); pneumonia (one); circulatory collapse (one); shock (one); paralytic ileus (one). Three of the eighteen patients nephrectomized for cancer died, a mortality of 16 per cent. It is generally acceded that removal of a kidney for cancer carries the highest mortality in renal surgery. We attach substantial significance in our favorable statistics to the exclusive use of the lumbar retroperitoneal approach. The type of nephrectomy performed has a definite influence on mortality, and we attribute a large measure of our success to careful selection of technic and to preoperative and postoperative care. There were seven deaths after classical nephrectomy. One death in six cases of nephrectomy par morcellement occurred in a sixty-seven-year old man presenting pyohydronephrosis and ectopia. There were no deaths following the subcapsular method employed by us in four cases; none after two-stage nephrectomy in twelve critically ill patients and none after clampless nephrectomy in twelve.

The mortality following conservative kidney operations is naturally lower than that following radical intervention. It was relatively low in our series, six deaths occurring in 531 patients, or 1.1 per cent. Causes of death were: pulmonary edema and intestinal obstruction (one); septicemia (three); pneumonia (one); coronary occlusion (one). The number of deaths after nephrolithotomy was the highest. The accepted rate is about 15 per cent and was 8 per cent in our hands. Possibly, inadequate drainage was responsible for the development of septicemia after nephrolithotomy in one case, because no nephrostomy or pyelostomy tube was employed. More recently, the thorough lavage of kidney wounds with physiological salt solution followed by the sprinkling of about 4 Gm. of sulfanilamide powder in the wound has reduced wound infection and lessened the incidence of septicemia.

One death followed pyelolithotomy, giving a mortality of 3.3 per cent in thirty-three cases; the usual mortality rate in pyelolithotomy is conceded to be about 7 per cent. It is interesting to note that no deaths followed eleven consecutive partial resections of the kidney for localized calculous pyonephrosis, polar cyst, hydrocalycosis with and without stone formation, etc. One kidney later had to be sacrificed by nephrectomy on account of multiple cortical abscess formation. Combined nephrolysis, ureterolysis, nephropexy and renal sympathectomy proved to be a benign operation; the mortality was nil in ninety-two consecutive cases. In one case in which adrenal tumor was suspected, exploratory lumbotomy failed to reveal this lesion; ptosis was encountered, and nephropexy and sympathectomy were carried out. The patient died three days later from coronary occlusion. This death can hardly be chalked up against nephropexy as the operation was not deliberately performed. It is gratifying to report that there were no deaths from postoperative anuria, the former bugbear of kidney surgery. This complication, that was so frequent in the early days of kidney surgery, has been eliminated by forced fluid intake and the intravenous administration of glucose solution prior to operation.

NEPHRECTOMY

Classical Nephrectomy. This was employed in the majority of our cases requiring radical surgery (78 out of 112 cases). The lumbar retroperitoneal route was routinely used and proved consistently satisfactory. The transperitoneal attack was not employed on account of its higher mortality and more serious complications. In twelve patients presenting large tumor or destructive lesions existing in the high placed, adherent kidney, it was necessary to remove the twelfth rib, and in one the eleventh as well, in order to obtain adequate exposure. After clamping the kidney pedicle, the vessels were ligated individually or *en masse.* Early clamping of the renal pedicle and gentle handling of the tissues in nephrectomies for malignancy minimized metastasis by preventing the dissemination of cancer cells into the bloodstream during manipulation of the kidney.

Nephroureterectomy. Complete nephroureterectomy was performed in eleven cases presenting carcinoma of the kidney pelvis, primary carcinoma of the ureter, ureteritis cystica, renal tuberculosis and hydronephrosis associated with megaloureter or calculous ureteritis. The lower portion of the ureter was exposed by a separate retroperitoneal incision in the lower abdomen, and in cases of neoplasm of the renal pelvis and of primary growths of the ureter the intramural portion was thoroughly fulgurated.

Subcapsular Nephrectomy. The technical difficulties encountered in extirpating the kidney presenting extensive adhesions were diminished by the application of subcapsular nephrectomy. It is the only safe method that can be employed in patients presenting pathological conditions complicated by extensive adhesions, as it preserves the integrity of the pleura and peritoneum. The successful outcome obtained in the four cases in which this operation was deliberately chosen bears out this point.

Nephrectomy par Morcellement. In certain pathological conditions the kidney was so friable that it could not be extirpated intact. In six cases of this type we removed it in pieces.

Two-stage Nephrectomy. This was performed on twelve critically ill patients for the relief of partially or totally closed hydronephrosis complicated by infection, stone or rupture, pyonephrosis associated with tuberculosis or calculus and perinephritic abscess accompanying cortical abscess formation or destructive renal lesion. These patients were in no condition to undergo the operative shock attending immediate radical removal of the diseased kidney, and probably would not even have survived the anesthetic. Under local anesthesia, therefore, the first stage consisting

of nephrostomy drainage was done, and after ten to fourteen days when sufficient improvement warranted, nephrectomy was carried out. By employing early nephrostomy, we were able to save several kidneys which were otherwise destined to be sacrificed by nephrectomy. We believe that the choice of this procedure was an important factor in reducing our mortality for nephrectomy, and that it enabled us to offer a life-saving alternative to patients who would have been abandoned as hopeless.

Clampless Nephrectomy. This is the latest modification and was utilized in twelve of our series. Clampless nephrectomy is applicable to pathological conditions occurring in anomalous kidneys with peculiar distribution of the blood vessels, as well as to certain anatomically normal kidneys in which it is possible to ligate the vessels separately or *en masse.* It has been successfully carried out in cases of tuberculosis, hydronephrosis, pyonephrosis and ectopic kidney with destructive disease. We are satisfied that in our cases it was followed by less shock, fewer complications and smoother convalescence than the clamp method. Such observations have led us to apply this more benign form of nephrectomy to a greater number of cases.

CONSERVATIVE OPERATIONS

Repair of Hydronephrosis. One of the most destructive pain-producing and debilitating of renal phenomena which is capable of correction is hydronephrosis. In a few of our cases it was congenital in origin, but in the great majority it was of the acquired type. It was caused by obstructive lesions consisting of ureteral stone, valve or stricture formation of the ureteropelvic junction, extrinsic lesions exerting pressure on the pelvic outlet, or kinked ureter due to renal ptosis. In this review we are not discussing the great number of patients who were treated by cystoscopic maneuvers consisting of ureteral dilatation, removal of stone, etc. Surgical relief of hydronephrosis in our fourteen patients included correction of the obstructing lesion and repair of the dilated pelvis. In those cases associated with pain, renal sympathectomy was simultaneously carried out; in those presenting renal ptosis nephropexy was performed. We adhered to the principle of nephrostomy or pyelostomy drainage, and employed the ureteral splint in order to avoid postoperative distortion of the ureter. Application of these essential technical points prevented progressive destruction of the kidney.

Nephrolithotomy and Pyelolithotomy. In dealing with kidney stone, several factors were considered before deciding on the form of operation best suited to the individual case. The condition of the contralateral organ, associated renal disease and the position, size and shape of the calculus were carefully evaluated. In some patients nephrectomy was mandatory. If conservatism was warranted, we used pyelolithotomy whenever possible (thirty-three cases), as it is accompanied by less hemorrhage, sacrifices no renal tissue and is followed by fewer complications than nephrolithotomy. However, by employing nephrolithotomy (thirty-four cases), one is less liable to leave stones behind when there are incrustations in the papilla of the kidney. A combined pyelotomy and nephrotomy incision advocated by the author proved the most satisfactory for removal of certain staghorn and tricornute calculi. Routine drainage of the calculous kidney by nephrostomy or pyelostomy was carried out in order to reduce intrarenal tension caused by postoperative edema. At the time of operation, pathological conditions favoring stone formation were corrected as far as possible: the ptosed kidney was suspended, the painful kidney denervated, obstructive lesions of the ureteropelvic junction relieved and the poorly draining, infected hydrocalyx resected.

Renal Resection. Resection of a portion of the kidney is indicated for benign pathological lesions localized to either pole in the anatomically normal kidney as well as in the congenitally anomalous organ. Its

special merit lies in the treatment of localized lesions of the solitary kidney and the various types of diseased anomalous kidney with separate blood supply. Heminephrectomy was performed for removal of the distended half of a double pelvis and the hydronephrotic half of a horseshoe kidney. In patients presenting polar lesions such as solitary cyst, infarct, abscess, carbuncle, localized pyonephrosis, etc., the kidney can be saved, as these lesions are amenable to resection. In our group of cases, renal resection was applied to localized pyonephrosis in one and solitary polar cyst in three. Primary ligation of the nutrient blood vessels eliminated the unpleasant complication of primary and secondary hemorrhage. We were able to remove successfully and with minimal loss of kidney substance the above localized renal lesions by employing the wedge-shaped excision extending into healthy tissue. The cut surfaces were approximated with chromic mattress sutures mounted on lubricated atraumatic needles, and the flaps replaced and ligated over pieces of fat. In four cases of calculi located in the lower calyx associated with ulcerative pyelonephritis, resection of the lower pole was carried out. This procedure prevented recurrence of stone by removing the poorly draining, chronically infected lower calyx. Renal resection for biopsy was performed in one instance. All but one of these patients made good recovery and are now leading normal lives. This one later required nephrectomy because of subsequent abscess formation. Repeated follow-up examinations revealed no recurrences. One cannot fail to recognize that these individuals were benefited by a conservative kidney operation which, rather than depriving them of an entire vital organ only a part of which was diseased, preserved the healthy functioning portion to maintain its physiological rôle. The greatest care in selection of candidates is absolutely essential, as is precision technic; but the recompense of restoring health and lengthening life is being reaped by an ever increasing number of progressive kidney surgeons.

Nephrostomy. Under certain conditions nephrostomy is a life-saving procedure. When ureteral catheterization failed to relieve calculous anuria resulting from complete obstruction of the solitary kidney, we resorted to nephrostomy or pyelostomy drainage as the only hope in three cases. Nephrostomy was utilized six times prior to two-stage nephrectomy for obstruction and in six patients presenting pyonephrosis. In one outstanding case in this group, the first stage (nephrostomy) proved sufficient and converted the proposed treatment from a radical to a conservative intervention. Among the eleven others was the case of W.H., who entered the hospital in an extremely weakened, toxic condition and in severe shock. Examination revealed spontaneous rupture of the kidney with extravasation of urine, infection and hydronephrotic enlargement with stone formation. His condition was so poor that the first operation,—consisting of drainage of the kidney and perirenal tissues,—was carried out under local anesthesia. Following this intervention the temperature rapidly dropped to normal, and the patient soon regained his strength. Two weeks later, subcapsular nephrectomy was performed and the operation was crowned with success. Nephrostomy was also used by us prior to diversion of the urine by ureterocutaneous or uretero-intestinal anastomosis, and in rare instances for diagnosis.

Drainage of Perinephritic Abscess. In dealing with our eighteen cases of perinephritic abscess, we employed copious drainage, using cigaret drains or the petrolatum gauze type, and removing a little of the packing each day—usually taking from ten to fourteen days for its entire removal —so that the abscess cavity would heal from the bottom. We advise against the common practice of removing the entire drain in twenty-four to forty-eight hours, because the superficial portion of the wound

may heal, allowing the original abscess to reform often in larger proportions than before.

In cases of perinephritic abscess secondary to destructive inflammatory conditions of the kidney in which nephrectomy is indicated, we recommend a two-stage operation as described under that heading. A case exemplifying the value of drainage preliminary to nephrectomy for secondary perinephritic abscess is that of S. M., aged fifty-nine, who was admitted to the hospital in a seriously debilitated condition. Examination revealed a calculous, tuberculous pyonephrosis and secondary abscess involving the perirenal tissues of the loin, as well as a huge abscess that had perforated the diaphragm and extended into the pleural cavity as far as the second rib. The first stage operation consisted of drainage of the lower perinephritic abscess. In ten days the patient's condition was so improved that nephrectomy was safely carried out, at which time it was necessary to remove the twelfth rib. Two weeks later a third operation was performed, consisting of drainage of an enormous abscess involving the chest cavity. In order to obtain adequate drainage, the eleventh rib was resected and the extensive abscess cavity thoroughly lavaged with physiological salt solution and packed with five yards of petrolatum gauze. The gauze was slowly removed, and after many weeks' convalescence the wound healed and the patient was discharged restored to good health.

Nephropexy. It is gratifying to remark that nephropexy now occupies its proper place among the conservative operations on the kidney. Ptosed kidneys are prone to chronic infection and stone formation by reason of stasis, and dependent drainage should be re-established at the earliest possible moment. The operation is clearly indicated in that group of patients suffering from pain, gastrointestinal symptoms and nervous phenomena caused by ptosis and torsion of the kidney. It is routinely employed by us for surgical suspension of the ptosed kidney which has been exposed for another conservative operation. In the present series, the author's method of nephropexy was used in most cases, preceded by nephrolysis and ureterolysis. Kinked ureters were released from adhesive bands or aberrant vessels; the kidney pedicle was carefully exposed, providing a clear field for the delicate operation of denervation. The most minute technical details were observed in order to assure lasting fixation of the kidney in its normal anatomical position. In cases presenting torsion of the kidney, detorsion was carried out. In one, the kidney pedicle was twisted to such an extent that it interfered with renal circulation, jeopardizing the integrity of the kidney. Detorsion and nephropexy in this case replaced the kidney in its normal position and relieved the patient of severe attacks of Dietl's crisis. The excellent results obtained in the ninety-two patients on whom nephropexy was performed have been a source of great satisfaction to us, and have increased our already staunch support of this beneficent kidney operation.

Renal Sympathectomy. Papin, in 1920, first observed experimentally that severance of the sympathetic nerve fibers of the kidney had no appreciable untoward effect on the functioning power or drainage of this organ. In 1921, he performed renal sympathectomy on the human being for relief of painful hydronephrosis of small size. This operation was soon adopted by the enterprising kidney surgeons of the world, and is now in general use for painful obstructive conditions of the kidney such as hydronephrosis, ptosis and torsion, nephralgia, sympatheticotonia, painful hyperdynamic mobility of the renal pelvis, etc. It was originally performed by the author in 1925, and in 1932 by him for the first time at The Southern Pacific General Hospital on a young woman with nephralgia. Although the operation is highly technical and requires scrupulous atraumatic handling of the renal vessels, it is a benign procedure as evidenced by the fact that there were no deaths in the ninety-

four patients on whom it was employed in this series.

Renal Decapsulation. This operation was first attempted with the object of increasing the collateral circulation of the kidney. It was practiced in cases of acute nephritis associated with uremia and anuria and for the relief of chronic Bright's disease in patients in whom other methods failed. Thorough trial proved the transitory nature of its decompressive action on the kidney, and it has now been virtually abandoned by us (three cases in 531 conservative operations).

CONCLUSIONS

The low mortality rate and excellent results obtained by nephrectomy in this series illustrate what can be accomplished by proper selection of cases, meticulous technic, careful preoperative and postoperative treatment and the judicious choice of the type of nephrectomy in a given case. The gratifying results obtained by the various conservative kidney operations analyzed in this review present an impressive testimonial to the preservation of renal tissue and the relief of suffering.

SUMMARY

1. A review of 643 kidney operations performed at The Southern Pacific General Hospital between January 1, 1930, and July 1, 1943, was made with the object of bettering surgical judgment, improving technic and reducing mortality.

2. One hundred twelve nephrectomies and 531 conservative operations are reported.

3. The mortality for all operations on the kidney was 2.2 per cent: nephrectomy 7.1 per cent; conservative interventions 1.1 per cent.

4. The mortality for nephrectomy was unquestionably lowered by the exclusive use of the lumbar retroperitoneal route and by careful selection of the type of nephrectomy best suited to the individual case, viz., the two-stage operation; clampless nephrectomy; subcapsular extirpation; removal par morcellement.

5. Our efforts to preserve renal tissue are exemplified by the fact that we performed six times the number of conservative operations as radical. Gratifying results were obtained by the following conservative procedures: surgical correction of hydronephrosis; nephrolithotomy or pyelolithotomy for removal of stone; resection of a portion of the kidney for localized polar lesions; renal sympathectomy for relief of pain; nephropexy for the correction of painful renal ptosis, and the life-saving measure of nephrostomy prior to two-stage nephrectomy and ureterostomy and for drainage of the obstructed solitary kidney.

THE OUTLOOK ON CARCINOMA OF THE STOMACH

M. JORDAN THORSTAD, M.D.

Surgical Service of Harper Hospital

DETROIT, MICHIGAN

CARCINOMA of the stomach constitutes one of the most serious of all medical problems. A favorable outcome in a patient with cancer of the stomach is more common now than in the past, primarily because of improved diagnostic methods and better surgical technic. Many patients die each year without entering a hospital for treatment. Oughterson[1] reported that in New Haven, Connecticut, only 58.0 per cent of these patients were treated in a hospital and Saltzstein and Sandweiss[2] found a 59.0 per cent hospitalization of 365 consecutive deaths from carcinoma of the stomach in Detroit.

There are many impressive reports on the treatment of carcinoma of the stomach, especially from large clinic practices. A truer picture of the cancer problem is to be found in the statistics of unselected cases such as are seen in every community in the United States.

In order to evaluate the trends and end results in a large group of unselected cases, the admissions for cancer of the stomach in two large general hospitals were reviewed. This study included 970 patients with gastric malignancy admitted to Harper and Receiving Hospitals for the fifteen year period from 1928 to 1942. Harper Hospital is a 600 bed general hospital devoted almost entirely to the care of private patients. Detroit Receiving Hospital is a 500 bed city hospital devoted to the care of charity and indigent patients. This made possible an immediate division and comparison of the cases from two distinct social and economic groups.

HARPER HOSPITAL

During this fifteen-year period, 1928 to 1942, there were 454 patients treated for carcinoma of the stomach in Harper Hospital. This is an average annual admission of thirty patients. The ratio of males to females was 2 to 1 or 302 males to 152 females. The average age for the entire group was fifty-eight years and the age extremes were from thirty to ninety-three years. Of this entire series, 192 patients or 42.3 per cent were considered to be clinically inoperable and entirely without hope of cure. The hospital mortality rate for this group of inoperable patients was 26.5 per cent. It is evident from these figures that one-fourth of the patients who enter the hospital are in such a critical condition that they die of the disease in a relatively short time.

Fifty-seven per cent of all patients admitted to Harper Hospital were submitted to surgery. This ratio conforms very well with the reports of operability given in the literature. There was an operative mortality rate of 43.1 per cent for the 262 patients submitted to surgery. The operative procedures performed were exploratory laparotomy, jejunostomy, gastrostomy, excision of the ulcer, gastroenterostomy and subtotal gastric resection. The disposal of the 454 patients with carcinoma of the stomach is clearly illustrated in Figure 1.

Of those patients submitted to surgery, 111 or 24.4 per cent of the entire series were found to be inoperable and biopsy or nothing at all was done. The mortality rate for this group of patients was 26.1 per cent. During this fifteen-year period only four jejunostomies, three excisions of ulcers and seven gastrostomies were performed, amounting to 3.1 per cent of the entire series.

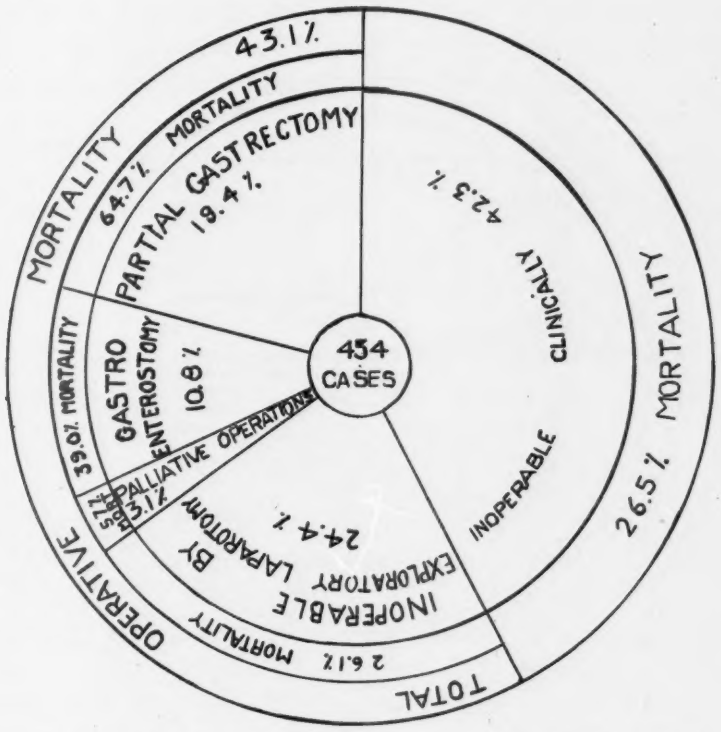

FIG. 1. Distribution of carcinoma of stomach, Harper Hospital, 1928–1942.

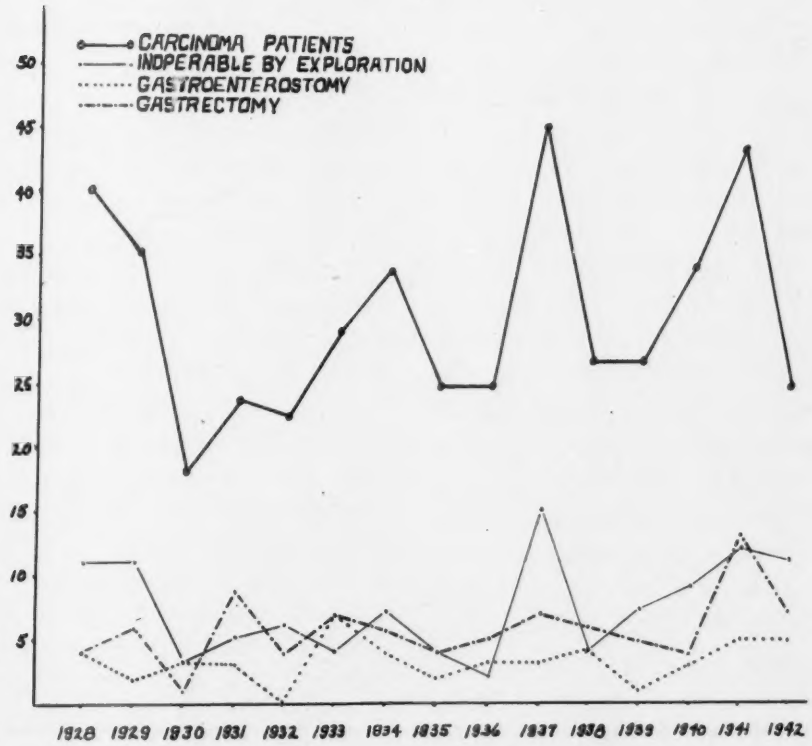

FIG. 2. Trends in treatment at Harper Hospital.

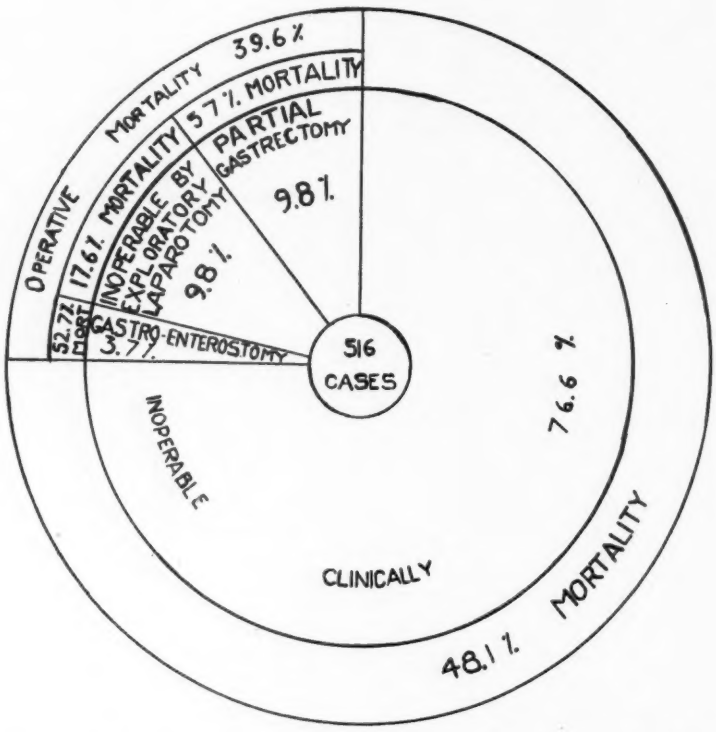

Fig. 3. Distribution of carcinoma of stomach, Receiving Hospital, 1928–1942.

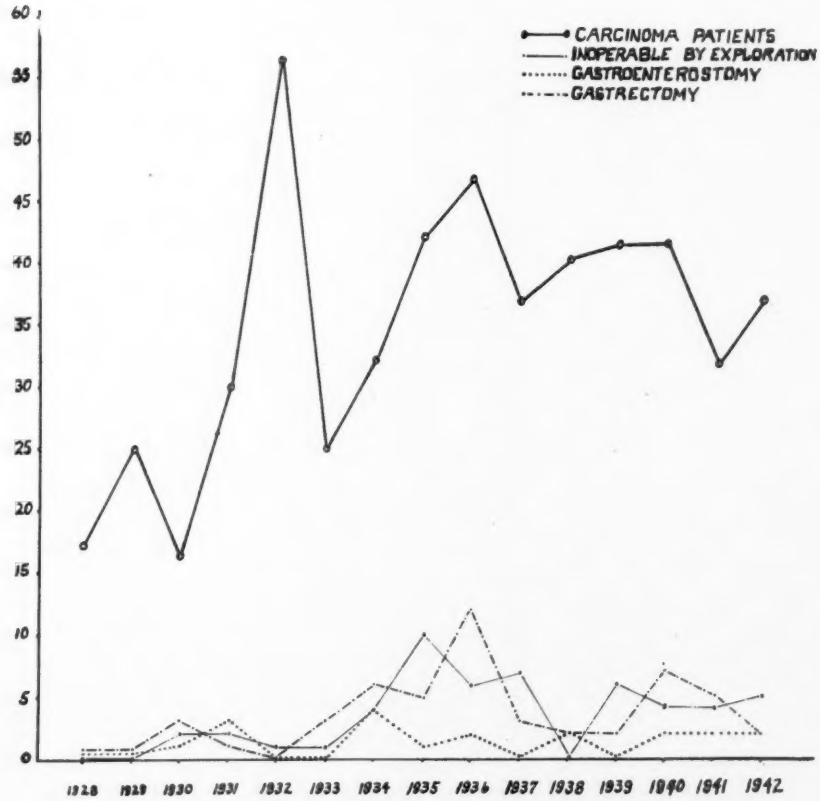

Fig. 4. Trends in treatment at Receiving Hospital.

Gastro-enterostomy was performed in forty-nine patients or 10.8 per cent of the series with an operative mortality rate of

RECEIVING HOSPITAL

During this corresponding fifteen-year period there were 516 patients treated for

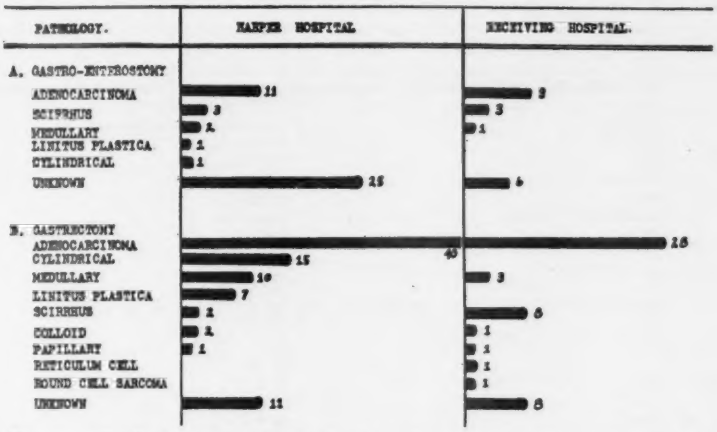

FIG. 5. Pathological diagnosis following gastro-enterostomy and gastrectomy.

39.0 per cent. Figure 2 shows that there has been no change in the popularity of this operation. An attempt should be made by the surgeon to obtain a pathological specimen either of the mass when the stomach is opened or a metastatic nodule or regional lymph gland. Of the biopsies taken the most common diagnosis was adenocarcinoma. The mean age of this group of patients was sixty years of age. The average duration of symptoms before operation was found to be seven months.

Gastrectomy was employed in eighty-eight cases or in 19.4 per cent of all the patients admitted to the hospital for this disease. The mortality rate for this operation was extremely high, being 64.7 per cent. There was a marked improvement in the mortality rate during the years 1941 and 1942 when twenty gastrectomies were performed with a mortality rate of 29.0 per cent. There has been a steady slow increase in the number of gastrectomies performed during these years as is shown in Figure 2. The mean age of this group was fifty-six years and the average duration of symptoms before operation was six months. Again the most common pathological diagnosis was adenocarcinoma followed by cylindrical cell and medullary carcinomas. There were seven lesions diagnosed as linitus plastica.

carcinoma of the stomach at Detroit Receiving Hospital, an annual admission of thirty-four cases. There were 399 males and 117 females, a ratio of 3 to 1. The average age for the series was fifty-four years, with age extremes of sixteen and eighty-seven years; 395 patients or 76.6 per cent of all gastric malignancy cases were clinically inoperable and the hospital mortality rate for this group of patients was 48.1 per cent which is extremely high. This dismal picture is the result of the low social station of these people in which the patient does not consult the doctor early enough in his disease. Therefore, of four patients who enter the hospital for cancer of the stomach, three are clinically inoperable and of these two die in a relatively short time without benefit of surgery.

There were only 121 patients submitted to surgery which is 23.4 per cent of all the cases. The operative mortality rate for all patients undergoing surgery was 39.6 per cent, a figure which in itself is lower than at Harper Hospital. Exploration revealed that another fifty-one patients had an inoperable lesion, leaving only seventy patients to benefit from either palliative or curative surgery. The mortality rate in the patient found to be inoperable by exploration was 17.6 per cent.

Gastro-enterostomy was performed in nineteen cases, or 3.7 per cent of the entire series. The mortality rate for this operation was 52.7 per cent. Figure 4 reveals that there is no marked change in the use of this operation. The mean age of the patients submitted to gastro-enterostomy was fifty-four years and the average duration of symptoms was 4.8 months.

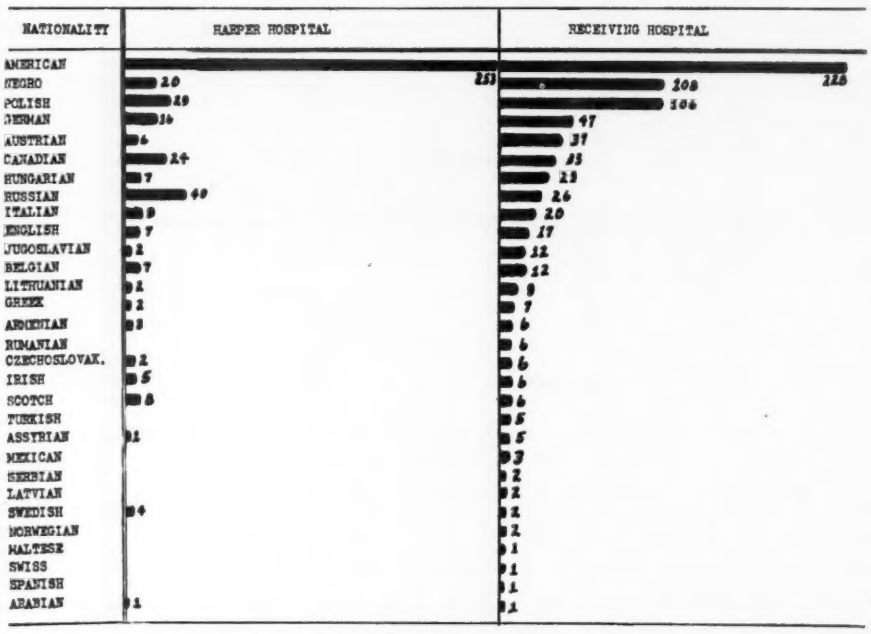

FIG. 6. Carcinoma of stomach by nationality, 1928–1942.

Gastrectomy was performed in fifty-one patients or 9.8 per cent of the series which again is a low percentage, but when compared to the number of gastro-enterostomies indicates a real appreciation of the value of attempting curative surgery. The mortality rate for this operation was 57.0 per cent or somewhat better than at Harper Hospital. Of the specimen studied, the most common diagnosis was adenocarcinoma. The average age of the patients undergoing gastrectomy was fifty-six years and the average duration of symptoms of the disease was 5.2 months. The youngest subject, a boy of sixteen years of age, had a subtotal gastrectomy for a round cell sarcoma.

The symptom incidence for all patients who were operated upon by gastro-enterostomy or gastrectomy at both hospitals was collected and set down in Table III. As one can see these patients fell entirely into the group presenting the "late symptom complex" associated with late carcinoma of the stomach.

TABLE II
SYMPTOM INCIDENCE
207 Operated Patients

Symptom	Incidence
Pain	158
Weight loss	152
Vomiting	113
Fullness	83
Mass	17

Data concerning the blood counts and gastric analysis were collected from the charts of this same group of patients and entered in Table IV. Interestingly enough, approximately one-fourth of these patients had a normal blood picture. Likewise 116 patients or 56.0 per cent of the group had no gastric analysis reported. Twenty per cent of the patients had a normal hydrochloric acid content of the stomach.

The distribution of the patients with gastric malignancy according to their nationality, as shown in Figure 6, revealed

a suprisingly high incidence of carcinoma in the negro race. The negro is prone to develop tumors from structures of mesodermal origin and more rarely develops tumors from structures of ectodermal and entodermal origin. Boyce,[3] reporting on carcinoma of the stomach from Charity Hospital in New Orleans, and Rippy[4] also found the incidence disproportionately high and Boyce postulated that this was due to their low threshhold of sensitivity. In this series the northern European showed a higher incidence of cancer of the stomach than did the southern European.

TABLE III
AGE INCIDENCE AND DURATION OF SYMPTOMS
Operable Cases, 1928–1942

	Harper Hospital	Receiving Hospital
A. Gastro-enterostomy	49 cases	19 cases
Mean age	60 years	54 years
Age extremes	37 to 88 years	32 to 73 years
Duration of illness	7 months	4.8 months
Sex incidence	30 M.; 19 F.	19 M.; 0.0 F.
B. Gastrectomy	88 cases	51 cases
Mean age	56 years	56 years
Age extremes	30 to 78 years	16 to 80 years
Duration of illness	6 months	5.3 months
Sex incidence	59 M.; 29 F.	44 M.; 7 F.

TABLE IV
INCIDENCE OF ANEMIA AND ACHLORHYDRIA
207 Operable Cases

Laboratory	Incidence
A. Anemia	
Normal	52
Moderate	46
Severe	72
Unknown	37
B. Achlorhydria	
Present	41
Absent	50
Unknown	116

SUMMARY

1. There is no marked annual increase in the admissions for cancer of the stomach to either Harper or Receiving Hospitals.

2. The percentage of clinically inoperable patients with cancer of the stomach was 42.3 per cent at Harper Hospital and 76.6 per cent at Receiving Hospital.

3. Fifty-seven per cent of all cases of gastric malignancy admitted to Harper Hospital were submitted to surgery in contrast to only 23.4 per cent at Receiving Hospital.

4. At Harper Hospital gastro-enterostomy was performed in 10.8 per cent of the entire series of patients while at Receiving Hospital only 3.7 per cent were treated thus.

5. Gastrectomy was performed in 19.4 per cent of the cases at Harper Hospital and in 9.8 per cent of the patients at Receiving Hospital. The mortality rate for gastrectomy at Harper Hospital during 1941 and 1942 was 29.0 per cent, a marked improvement over other years.

6. Finally, no evidence was found to indicate a marked improvement in either diagnosis or treatment of early carcinoma of the stomach during this fifteen-year period.

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OSTEOGENIC OSTEOLYTIC SARCOMA OF THE OS PUBIS

SIDNEY T. FRIEDMAN, M.D.
Associate Surgeon, Jewish Memorial Hospital
NEW YORK, NEW YORK

OSTEOGENIC sarcoma in general is an unusual disease. Osteogenic sarcoma involving the pubic bone is extremely rare. In several large series of cases of osteogenic sarcoma which were studied and reported by Meyerding and Valls,[38] Coley and Coley,[11] Ewing,[25] Geschickter and Copeland,[28] no case was reported as attacking the os pubis.

The only authenticated cases which I have been able to discover in the literature are those of Shoemaker and Robertson,[48] who reported the tumor on the left pubis and adjoining ischium and that of Campbell[5] which also involved the ischium and pubis. In the latter instance, the diagnosis was made on clinical and roentgenographic findings; no biopsy was performed. Two questionable cases, without the benefit of histologic examination, are those recorded by De Brun, in 1881,[22] and by Picque, in 1894.[42]

DIAGNOSTIC CRITERIA

Age. Osteogenic sarcoma is a disease of youth rather than old age. It is very unusual in those over fifty years. The average age in the series reported by Meyerding and Valls[38] was 29.3 years.

Sex. The ratio of male to female is approximately 2 to 1 (Meyerding and Valls[38]; B. L. Coley[8].

Trauma. The incidence of trauma as an etiologic factor has been variously estimated at approximately 50 per cent by Meyerding and Valls[38] and B. L. Coley.[9] When one considers the great number of injuries which take place and the relatively small number of sarcoma which develop, one is inclined to dismiss injury as an exciting factor. This is the stand taken by Ewing[25] who believes that the cause is probably a disturbance in the intrinsic growth factors.

Pain. The pain associated with this condition is characteristic. It may precede recognition of the disease by a few weeks or by many months. At first it may be intermittent, but it soon becomes constant and is intensified at night. The pain due to sarcoma is aggravated by traction in contradistinction to that of inflammation which is usually alleviated by traction (Campbell[4]).

Swelling. Swelling is a sign which may appear early if the lesion is superficially placed. If deeply seated, it appears late.

X-ray. The *x*-ray findings are sufficiently distinctive to enable the roentgenologist to make the diagnosis. The lesion involves the ends of the long bones as a rule. It is located in the ends of the diaphysis, may invade the epiphysis, but rarely involves the joint. The bone shaft is in the center of the tumor and radiating spicules of bone are evident. The latter are indicative of osteoplastic reaction.

Pathologic Fracture. Pathologic fracture occurs in almost one-half of the cases of osteogenic sarcoma (Bloodgood and Geschickter[2]).

Microscopic Findings. Biopsy, either open or closed, is an invaluable aid in making the diagnosis. Microscopically, osteogenic sarcoma is a malignant tumor arising from tissue predestined to form bone producing cells. The chief feature in the structure of osteogenic sarcoma is the production of immature and atypical bone, cartilage, and osteoid tissue by pleomorphic tumor cells. The cells are hyperchromatic, spindle, rounded, and polyhedral. Some of the blood vessels are the normal vessels of the affected tissue, while others are the tumor

blood vessels, lined by tumor cells, thus giving rise to metastases. Giant cells form from the overgrowth or fusion of tumor cells. Foreign body giant cells may be present and may form the basis for an erroneous diagnosis of benign giant cell tumor (Ewing[25]). Osteogenic tumors possess the property of osteolysis and osteogenesis in varying degrees. Either the destructive or productive feature may almost wholly predominate.

FIG. 1. *X*-ray taken on admission to hospital; arrows indicate site of lesion.

FIG. 2. *X*-ray taken three months after biopsy; arrow shows pathologic fracture which is still present.

Serum Phosphatase. Serum phosphatase (alkaline) is associated with bone formation. The higher the phosphatase content of the blood serum, the worse is the prognosis in osteogenic osteolytic sarcoma since it connotes greater activity.

CASE REPORT

The patient, a white woman, forty-two years of age, employed as an office worker, was admitted to the Jewish Memorial Hospital on March 16, 1940, complaining of pain in the right groin which radiated along the anterior and inner aspects of the right thigh. This symptom had been present for six months. At the onset it was intermittent in character, but three weeks prior to admission it had become constant and much more intense. Standing and walking aggravated the pain. There were also complaints of frequency of urination and nocturia. The patient had lost nine pounds in weight.

Examination revealed a well nourished and well developed white woman. There were no significant findings in the head, neck, chest, or abdomen. Slight tenderness was found in the right inguinal region. Pain was present on motion of the right thigh in all directions, but there was no limitation of motion in any direction. Swelling and redness were absent. The urine examination was negative, and the blood count was normal. A lesion of the right pubic bone was suspected and this suspicion was verified by *x*-ray.

FIG. 3. *X*-ray taken two and one-half years later.

Roentgenograms taken two days after admission were reported upon as follows: the plates "reveal no gross abnormalities of the lower portion of the pelvis and hip joints. The right horizontal ramus of the pubic bone shows extensive destructive changes. Examination of the skull, skeletal structures and spine, and also blood serum studies would help to differentiate between giant cell neoplasm and malignant infiltrations of the pubic bone. If no further light on this destructive bone lesion can be ascertained, would suggest biopsy for diagnosis." (Figs. 1, 2 and 3.)

In accordance with the roentgenologist's suggestion, further studies were made:

"Roentgenographic examination of the skull, thorax, and lumbo-sacral spine exhibit no evidence of any osseous destruction. Moderate hypertrophic, osteoarthritic changes are present in the lower dorsal vertebrae. Extensive bone changes are again discerned in the horizontal ramus of the right pubic bone and have the appearance of a giant cell tumor. However, malignancy can only be ruled out by biopsy."

Blood serum studies revealed the following pertinent findings:

Serum calcium	11.2	(normal 9–11)
Serum phosphorus	4.5	(normal 3–4)
Serum phosphatase (alkaline)	18 units	(normal 1.5–4)

The phosphatase is markedly elevated and this is what one would expect with extensive bone destruction. The urine examination for Bence-Jones protein was negative.

In view of all the facts, it was decided to perform a biopsy. It was quite evident from the roentgenograms that even though the lesion present should prove to be a malignant growth, radical surgery would be out of the question because of the location and the extent of the lesion. The procedure was to expose the body and the right superior ramus of the pubic bone. A portion of the cortex of the superior ramus, about one inch long, was removed and as much as possible of the medulla was curetted. A specimen was also taken from the body of the pubis.

The patient made an uneventful recovery and was discharged from the hospital on April 21, 1940, approximately five weeks after admission. She was readmitted eleven days later for a pelvic abscess which pointed through the right lateral vaginal wall. It was incised and drained and the patient was discharged one week later.

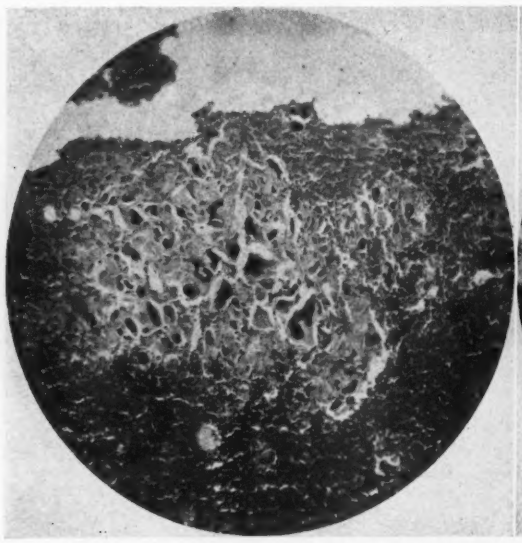

FIG. 4. Section of tissue removed at biopsy. × 135.

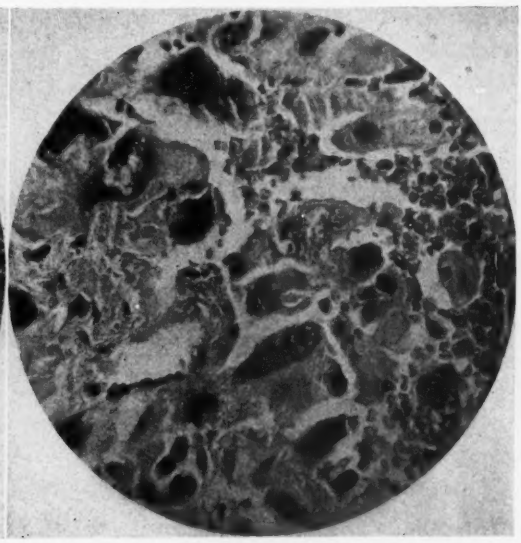

FIG. 5. Section of tissue. × 600.

Roentgenograms taken three weeks after operation and after radiotherapy revealed no change from the previous observations except for a fracture at the medial extremity of the superior ramus of the pubic bone. This fracture was undoubtedly pathologic in nature since the degree of trauma incurred during the operation would not have produced a fracture in normal bone.

Microscopic examination of the removed bone made by Dr. Alfred Angrist showed "large fragment of rather anaplastic tumor tissue consisting of a great variety of cells. Predominant are large polyhedral cells of almost giant measurements showing excessive variation in size and shape. The nuclei of these cells likewise show considerable variation. Some of them are vesicular, others pyknotic. Mitotic figures are frequent. Other cells have several pyknotic nuclei suggesting giant cells. There is definite pleomorphism present. In some areas, spindle cells are seen. In other areas, vesicular closely placed cells suggesting early cartilaginous structure are present. Osteoid tissue is seen in some areas. Some hemorrhage and inflammatory reaction with signs of old hemorrhage in the form of pigment phagocytes

is noted. The diagnosis is anaplastic sarcoma suggesting an osteolytic osteogenic intramedullary tumor." This diagnosis was confirmed after additional studies of decalcified and specially stained material were made to rule out malignant variety of giant cell bone tumor, striated muscle tumor, and tumor of fat origin. (Figs. 4 and 5.)

In the thirty-one months that have elapsed since the patient was operated upon, she has received several courses of deep roentgen ray therapy (dosage: 6800 R in all). Yet, judging from the *x*-ray findings, there has been little appreciable change in the lesion. The last *x*-ray, taken on November 14, 1942, "discloses no essential change in the appearance of the lesion in the right ramus of the pubis. No further destruction is noted. There is sclerosis around irregular rarified areas with expansion of the bone and encroachment on the obturator fossa."

Symptomatically, however, there is a marked improvement. The patient has no pain or discomfort whatever, no tenderness or disability. She is able to walk and stand without the pain she suffered prior to her admission to the hospital. She has regained the nine pounds previously lost; in fact, her weight now is greater than it has ever been. She works at her usual occupation without any difficulty.

COMMENTS

The diagnosis of osteogenic sarcoma is made after careful consideration of history, physical examination, roentgenogram and biopsy. The first two factors have already been sufficiently considered. Probably overshadowing their importance is that of the roentgenogram. It is very frequently the deciding factor in the diagnosis. Ewing[24] considers it of more importance than a biopsy. He believes that, in general, the roentgenologist is better able to make the diagnosis than the pathologist. The histologic characteristics of bone tumors vary greatly depending upon the particular portion of the tumor biopsied.

There seems to be some difference of opinion as to the type of biopsy which should be performed. Meyerding[34] favors the open biopsy. He believes that it offers little danger if carefully done. Ewing,[24] on the other hand, is opposed to it on the grounds that hemorrhage, accelerated growth and metastases may result. He believes that local variations in tumor tissue are often misleading. In his opinion, the diagnosis should be made easily on the clinical and roentgenographic findings, especially the latter.

However, he does concede that an aspiration biopsy is permissible since it avoids the mechanical dangers which he thinks are inherent in an open biopsy.

Prognosis. In the treatment of osteogenic sarcoma in general, it is commonly accepted that early radical surgery offers the best prognosis, but the results at best are rather poor. Some men precede or follow surgery with *x*-ray therapy. The most encouraging feature in the treatment of this condition is that since the diagnosis is now being made earlier, and treatment instituted much sooner, the percentage of cures (five-year) has considerably increased. At the turn of the century, it was about 2 per cent. In 1923, it was 16.5 per cent, and, at the present time, it is approximately 23 per cent (Coley and Pool;[7] Mayo Clinic[36]). This percentage of cured patients in the Mayo Clinic statistics is higher than that reported from most other clinics. Incidentally, it includes cures by all methods, i.e., amputation, excision, and radiotherapy.

Treatment. The treatment of choice is early, high amputation. This, unfortunately, is sometimes impossible, either because of the location, size or extent of the tumor, or because the patient refuses to permit a deforming operation. Excision of the lesion is frequently performed because more radical surgery is contraindicated. In some cases, again for the same reasons, only biopsy followed by radiation is the mode of treatment. This was the only possible procedure open to me in the case which is being reported.

In Meyerding's[36] series of cases, there are: 24.7 per cent five-year cures by amputation; 34.1 per cent five-year cures by excision with or without radiation; 9.1 per

cent five-year cures by biopsy followed by *x*-ray. The apparent contradiction in results from amputation and excision is due to the fact that many patients came to amputation after they have had more conservative measures tried without success. In other instances in which it is evident that cure is out of the question, amputation is performed as a palliative measure for the relief of intractible pain.

Those cases which are seen earliest after the onset of symptoms are usually the most malignant and, therefore, offer the poorest prognosis regardless of prompt amputation. This may explain Ferguson's[26] statement that early amputation offers a poorer prognosis than late amputation.

X-ray therapy alone offers a very poor prognosis (Codman[20]) and should be reserved for those cases for which more radical measures are refused or in which the location or extent of the lesion contraindicates any other treatment. Coley,[9] in a series of seventy cases treated only by *x*-ray, reported not a single five-year cure. Some men, among them Ewing,[25] have a preference for preoperative *x*-ray therapy followed by radical surgery. Ewing believes that the time spent in giving *x*-ray is not wasted and the danger of metastasis occurring during that interval is slight. There is the advantage, moreover, that it may aid in making the diagnosis which, in many cases, is not clear cut. If the growth responds well to *x*-ray therapy, it is, in all probability, not an osteogenic sarcoma. Roentgen therapy is frequently used postoperatively for pulmonary metastases, but here also the results in general are poor. Reports indicate that prolongation of life may be accomplished by this means (McReynolds;[39] Simmons[44]).

Coley's serum may be used, chiefly on empiric grounds. Today these toxins are little used. Bradley Coley[9] states that they may be of value in inhibiting the growth of pulmonary metastasis which he believes are present at the time of operation, but in such minute proportion as not to be demonstrable.

In the case under discussion, the only treatment available as has been stated, was deep *x*-ray therapy following biopsy because of the location and size of the growth. Since this form of treatment gives the poorest permanent results, it is gratifying that the patient still remains a happy, useful individual.*

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* Five months after this article was written the patient showed evidence of extension of the sarcoma from the pubic bone into the pelvis and of metastasis to the liver. Biopsy of the pelvic mass showed the same pathologic findings as the original biopsy. The patient went down hill very rapidly and died on October 17, 1943. No autopsy was obtained.

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A MENINGOCELE consists of a protrusion of a pouch of dura mater through a congenital defect in the skull. The usual situations are the root of the nose, over the occipital bone, or in connection with the anterior fontanelle. Very occasionally they appear through the base of the skull, in which situation they have been mistaken for nasal polypi, and attempted removal has resulted in fatal meningitis.

OPERATIVE POSITION FOR ULNAR NERVE TRANSPOSITION

CAPTAIN MARTIN DOBELLE
MEDICAL CORPS, ARMY OF THE UNITED STATES

AND

LIEUT. COL. SAMUEL E. PROCTOR
MEDICAL CORPS, ARMY OF THE UNITED STATES

NOT infrequently, operative positioning of a patient may mean the difference between prolonged formidable and easily performed surgery. The operative technic for ulnar nerve transposition, is in itself a well established one and presents no problem to the gentle operator. The positioning of the patient, however, is extremely awkward in relation to the surgeon and his assistants.

FIG. 1.

FIG. 2.

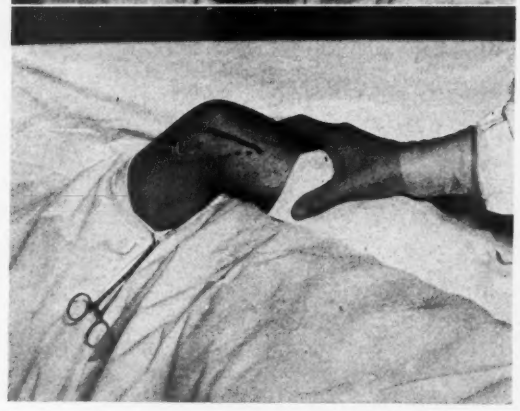

FIG. 1. Patient supine with arm in abducted manual traction.
FIG. 2. Patient supine with arm across chest and manually elevated shoulder extension.

As depicted in all photographs, the continuous curved line represents the incisional site, the x, being the medial epicondylar prominence of the humerus,

and the interrupted line, the area where the nerve is to be re-routed.

Figures 1 and 2 demonstrate those positions generally adhered to. The patient is supine and one assistant must remain in a steady position, exerting constant traction and firm purchase on a completely relaxed extremity. It is a physical impossibility for any one to maintain this position for more than several minutes at a time, and then not without considerably annoying, though unavoidable, "wobbling." A second assistant is therefore necessary to aid with the actual procedure,

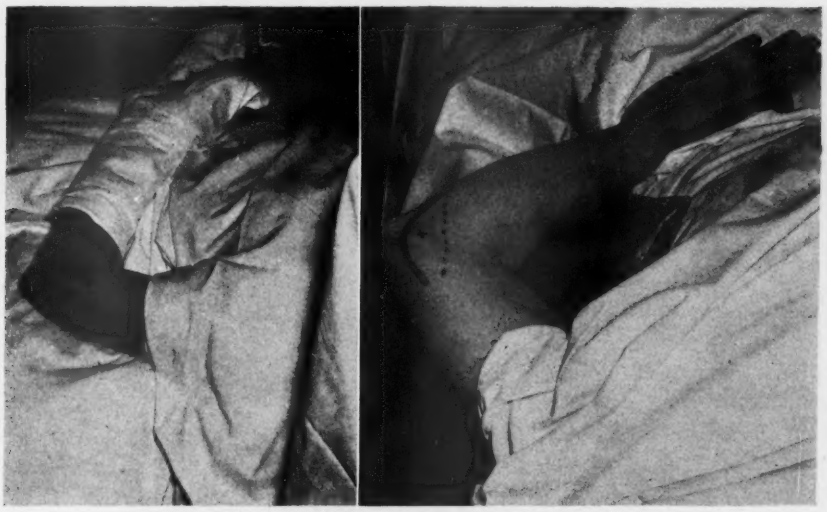

Fig. 3. Fig. 4.

Fig. 3. Patient prone with arm internally rotated.

Fig. 4. Represents a more detailed view of Figure 3, with the supporting mechanism of the pillow resting on a slight arm board extension from the side of the operating table, with the dorsum of the hand and wrist resting in the lumbar hollow.

Fig. 5. View of the facilitated proximity to the operative site without necessity of continued manual support of the extremity during the surgical procedure.

and even he is unable adequately to approach the operative field to be fully advantageous.

Figure 3 demonstrates the operative position of a patient for ulnar nerve transposition adhered to at the Station Hospital, Camp Reynolds, Pennsylvania. The patient is prone and the arm internally rotated, resting the dorsum of the hand on the small of the back.

Figure 4, viewed from above downward, demonstrates the details of the resting mechanism, with the supporting pillow and arm board projection.

Figure 5 demonstrates the comfortable proximity of the surgeon to the operative field.

Hence a delicate procedure can be gracefully performed, under direct vision, firm steadiness and with greater precision.

SUMMARY

An improved method of operative positioning of a patient for ulnar nerve transposition is described. It lends itself admirably in any procedure requiring approach to the mesial aspect of the elbow.

CIRSOID aneurism is a rare condition, but of importance owing to difficulty in treatment. It is due to dilatation of the arteries, which open more or less directly into venous spaces. Capillary naevi are sometimes seen in the overlying skin.

Case Reports

INTRATHORACIC GOITER*

CASE REPORT

JOSEPH L. DECOURCY, M.D. AND C. A. PRICE, M.D.
CINCINNATI, OHIO

ALTHOUGH substernal goiter was first described anatomically as far back as 1749 by Haller and clinically by Lingl in 1830, it was not generally recognized before 1899, when Schieff demonstrated the value of the roentgenogram in its diagnosis. The symptoms are usually vague, dyspnea often being the only complaint.

Today, with all facilities available, differential diagnosis is still difficult. Roentgenograms will usually demonstrate a tumor mass; but differential diagnosis must be made from sacculated aneurysm of the ascending arch of the aorta, persistent thymus, lymphosarcoma, Hodgkin's disease and forms of mediastinal tumor, especially dermoid and less frequently echinococcic cysts. Calcareous deposits should suggest a dermoid cyst but calcified areas are sometimes present in goiter and may occasionally be seen on a "bucky." In lymphosarcoma and Hodgkin's disease, treatment with *x*-ray will usually cause a regression of the tumor mass. It is our opinion that, even after careful and prolonged examination, diagnosis can only infrequently be made except by exploration.

Substernal goiters may be partial or complete, fixed or mobile. Such nomenclature as "wandering goiter," "spring goiter" and "goiter mobile" has been applied to the mobile type of substernal goiter.

That the partially substernal goiter is not an unusual condition is readily apparent from our own statistics. In our group of 15,000 thyroidectomies performed in the past twenty-five years, 15 per cent fell into this category. Completely substernal or intrathoracic goiters, on the other hand, are extremely infrequent. It is difficult to estimate from the literature the true incidence of this condition, as every surgeon differs in his definition of intrathoracic by degree.

In our last personal series of 1,000 thyroidectomies only three were completely intrathoracic. It is of interest that all three cases proved to be adenomas, thus further confirming the general belief that intrathoracic goiters originate from adenomas or adenomatous goiters.

One of the cases of intrathoracic goiter was an adenoma which was continuous with the left lobe of the thyroid and which was possible to remove through a low collar incision of the neck. This adenoma measured 10 cm. in length and 7 cm. in diameter.

In the second case the goiter was removed by splitting the sternum. Although it was not as large as in the first case, it was very adherent to the surrounding structures.

In the third case, which we are presenting in detail, the goiter was the largest yet reported and was entirely intrathoracic, being connected to the trachea in the neck by only a thin fibrous band. In fact we think it might be considered an ectopic or aberrant thyroid. When removed it measured 15 cm. in length,

* From the Department of Surgery, DeCourcy Clinic, and the Good Samaritan Hospital.

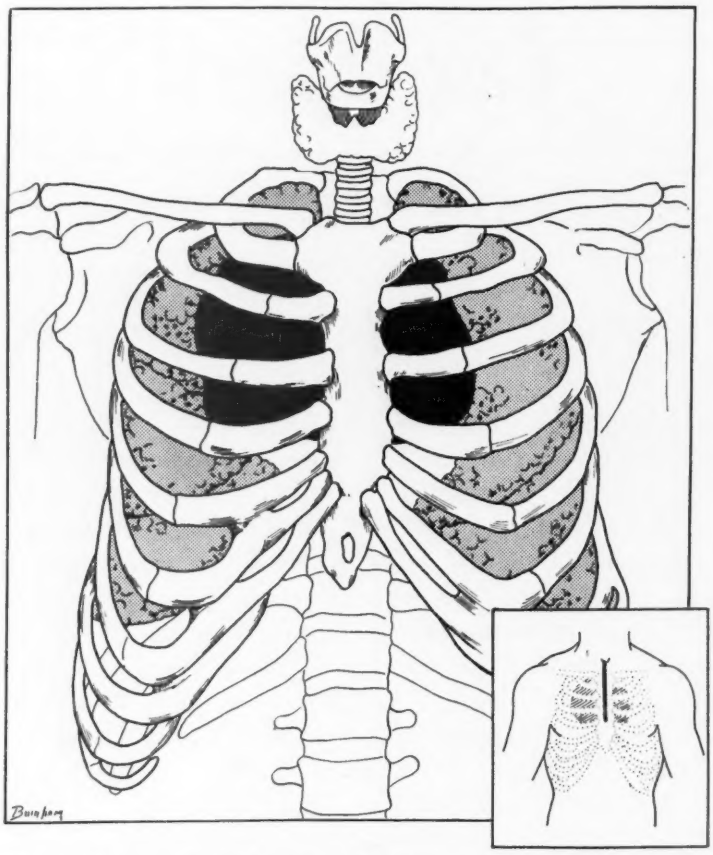

FIG. 1. Appearance of tumor within thorax. Insert shows incision of sternum.

FIG. 2. Anteroposterior view showing deviation of trachea.

FIG. 3. Lateral view.

11 cm. in diameter and 8 cm. in depth, the largest intrathoracic goiter yet reported to my knowledge.

CASE REPORT

E. F., a male, aged forty-nine, weight 196 pounds, was seen at the clinic on May 15, 1943. He complained of dyspnea, occasional pains in the back and occasional epigastric distress. There were no other symptoms. When first distressed with dyspnea a year previously, he had consulted a physician who had prescribed some pills. While under this treatment he lost forty pounds in weight. He consulted another physician, who after examination advised *x*-rays of the chest. Roentgenograms revealed a tumor mass. *X*-ray treatments were then instituted. During this time he felt better and regained the forty pounds in weight. Follow-up roentgenograms, however, failed to show any regression of the tumor.

On examination at the DeCourcy Clinic, the patient, a barrel-chested individual, had a systolic blood pressure of 150, diastolic 100; pulse was 88; temperature 98.4°F. Urinalysis revealed specific gravity of 1.010, acid reaction, negative chemically. On microscopic examination, there was an occasional red blood cell, 10 pus cells per high power field and an occasional epithelial cell. Examination of blood showed hemoglobin of 88 per cent, red count of 4,580,000 and white count of 7,000. Differential was essentially normal. Wassermann and Kahn tests were negative.

X-ray of the chest showed a thickened pleura over the right lung. Lung fields and pleura were otherwise clear. A very large tumor mass could be visualized in the region of the mediastinum, extending both to the right and left. This suggested an aneurysm of the aorta; the heart outline was not enlarged.

X-ray of the gallbladder was taken on May 21st. The roentgenologist reported that the gallbladder was not visualized and advised another examination. *X*-ray of front and side views of chest taken on this date showed a large, well circumscribed shadow of increased density in the upper anteriomediastinum, which displaced the trachea backward and to the right. It appeared to be continuous with the arch of the aorta and therefore suggested the presence of a large aortic aneurysm. The heart outline was not enlarged.

On June 12th, further *x*-ray of chest showed the same findings as previously described. There were no changes.

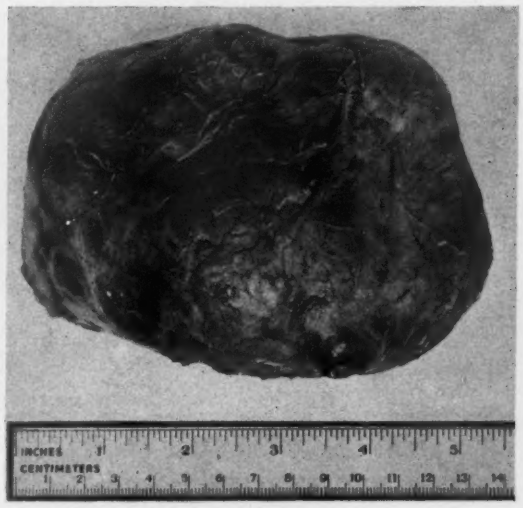

Fig. 4. Tumor after shrinkage, 13.5 by 11 by 8 cm.

Repeated fluoroscopic examinations, however, failed to convince us of the diagnosis of aneurysm. More deep therapy was applied but there was no regression.

Believing that we might be dealing with an intrathoracic goiter, 10 drops of Lugol's solution were given three times daily for ten days. The patient entered the hospital on June 30, 1943. The thyroid in the neck was not palpable.

On July 3, 1943, operation was performed under nitrous oxide and oxygen anesthesia. A low collar incision was made over the neck, which was very short, the thyroid cartilage being only 1 inch above the sternal notch. The left lobe of the thyroid could not be found and the right lobe was very small and flattened against the trachea. No nodules were palpable.

As the finger was inserted beneath the sternum, the upper border of the tumor could be palpated. The sternum was then split lengthwise in its middle portion down to the xiphoid. The electric circular saw and chisel and hammer were used. Where the halves of the sternum were separated, an exposure of about 2½ to 3 inches was obtainable. The tumor was seen lying beneath in the midline with the pleura thickened and pushed downward by the tumor.

Enucleation was started and it was thought that an easy removal would be effected; however, the adhesions became very dense where attached to the pericardium. Bleeding became profuse and necessitated stopping the operation and packing about the mass with hot moist

packs. A transfusion was added to the intravenous glucose solution and the patient was returned to bed.

Twenty-four hours later the patient was sitting up in bed talking. Active bleeding had stopped; pulse was 90 and of good volume; respirations were 28; temperature was 102°F. per rectum. Twelve hours later (thirty-six hours postoperatively) the temperature rose to 108°F. Respirations became quickened and labored, the pulse rapid, and the patient expired.

At autopsy the thorax was opened in the usual manner, by extending the midline incision and making a horizontal incision from the shoulders to the superior portion of the operative incision. Behind the sternum and ribs, there was an encapsulated tumor mass, about 15 cm. by 11 cm. by 8 cm., situated in front and to the left of the trachea which was compressed. The lateral and anterior sides of the mass were closely related to the lungs and pleuras. The lateral and inferior sides were related to the pericardium which was shoved to the left. The superior side was related to the sternum and clavicles. Thyroid lobes were thin, atrophic and compressed by the tumor mass, which weighed 655 Gm. and was removed in its entirety. Cut sections showed fibrosis and small cysts. The left lung weighed 610 Gm., the right lung 650 Gm.; both showed hypostatic congestion and mild anthracosis, otherwise negative. The heart weighed 350 Gm. and was negative. Coronary arteries showed no pathological condition and there were no pathological changes of the aorta.

FIG. 5.

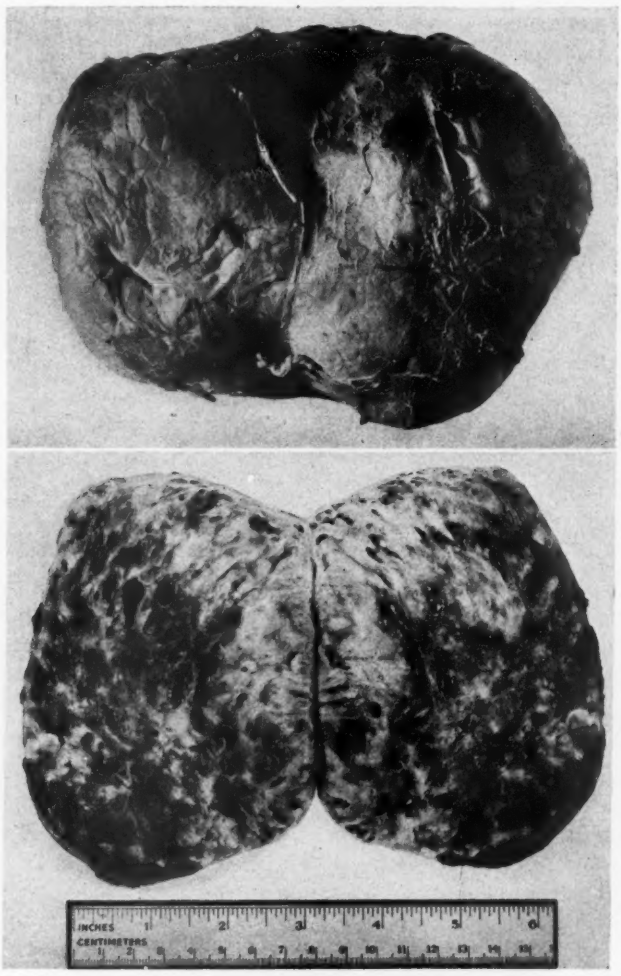

FIG. 6.

FIG. 5. Tumor showing tracheal groove and previous attachment to pericardium.

FIG. 6. Tumor halved longitudinally.

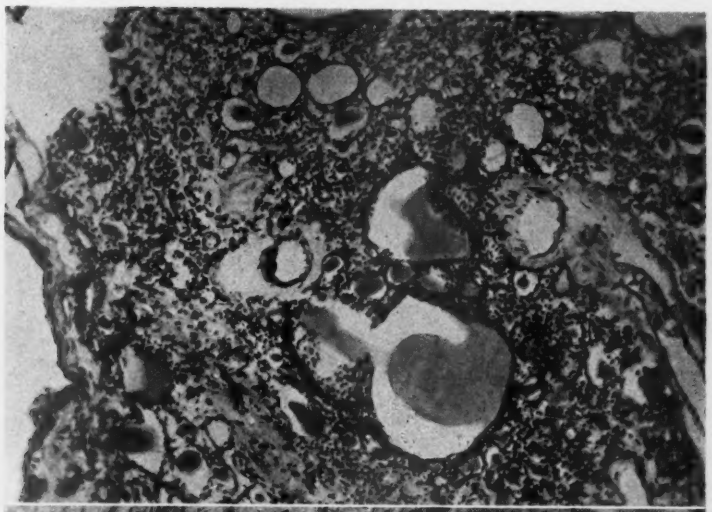

FIG. 7.

FIG. 8.

FIG. 9.

FIG. 7. Architecture is that of fetal adenoma.
FIG. 8. Hyaline degeneration and hemorrhage.
FIG. 9. Areas of fibrosis; slight infiltration of lymphocytes.

The pathological report was as follows: Anatomical diagnosis: (1) substernal adenoma of thyroid. Microscopic Diagnosis: (1) substernal fetal adenoma of thyroid; (2) lobular pneumonia.

COMMENTS

Whether this patient died in a thyroid crisis or whether the hyperthermia was terminal we are not prepared to say. Our impression was that it was a respiratory rather than a thyroid death.

The difficulty of differential diagnosis is again emphasized in the case reported.

The present day classification of intrathoracic goiter is vague. Descriptive terms such as substernal, retrosternal and subclavicular add to the confusion. We would suggest classifying all of them as intrathoracic. Further explicit description could be obtained by expressing to what degree the thyroid is submerged in the thoracic cage. For instance, if one-third of a lobe were intrathoracic, it might be called intrathoracic goiter "first degree." If two-thirds of the goiter were intrathoracic, it might be termed "second degree." This would facilitate reporting these cases and give us a better statistical approach as to their respective occurrence.

SUMMARY

1. The incidence of completely intrathoracic goiter is extremely infrequent, only three cases occurring in our last series of 1,000 thyroidectomies.

2. A case report is presented with operative and necropsy findings.

3. The difficulty of differential diagnosis is emphasized.

4. Simplification of descriptive nomenclature and a system of classification as to the degree of submersion of the thyroid in the thoracic cage are suggested. This would facilitate reporting cases of intrathoracic goiter and would offer a better statistical approach for future reference.

ADVANCED CANCER OF THE FACE*

TIBOR DE CHOLNOKY, M.D.
Diplomate of the American Board of Surgery; Assistant Attending Surgeon, Post-Graduate Hospital
NEW YORK, NEW YORK

THIS case is reported because of a successful result achieved in what appeared originally to be a hopelessly advanced case of basal cell carcinoma.

CASE REPORT

W. K., No. 22603, a white male, painter, aged fifty years, was admitted to the Tumor Clinic of the New York Post-Graduate Hospital, stating, that about three years ago he developed a small ulceration at the inner canthus of the left eye for which he received radium treatment elsewhere. The lesion apparently cleared up, and he was discharged as cured. Because of economic reasons the patient did not apply for treatment when the lesion reappeared until it reached the present proportion. (Fig. 1A.)

Examination showed an extensive, excavated basal cell carcinoma, involving the left orbital region, destroying the left eye, both lids (Fig. 1C) and infiltrating the inner canthus of the right eye. (Fig. 1B.) The tumor was fixed to the underlying bone structure, and had broken into the frontal and to the left maxillary sinuses.

The patient was presented before the Tumor Conference whose concensus of opinion was that because of the advanced condition a radical attempt at electrosurgical removal should be made. The patient was then referred to the author by Dr. William F. MacFee.

After a routine preoperative preparation the operation was performed July 1, 1937, under general anesthesia. The lesion was first circumscribed by coagulation-cutting current through the healthy tissues about 2 cm. from the tumor edge. Bleeding was controlled throughout the whole operation by coagulation. The tumor mass was then coagulated with a flat electrode and the coagulated tumor was removed piecemeal by an electric cutting loop.

The tumor at the right canthus was carefully removed in similar fashion, avoiding damage to the lacrimal duct. As the new growth involved the nasal bones and part of the frontal bones, it was necessary to coagulate and remove these involved structures. The left frontal sinus, as well as the left maxillary sinus, was invaded by the tumor which extended also into the anterior ethmoidal cells. These were coagulated and removed. The contents of the left orbit were enucleated, including the periosteum. When it was believed that the eradication of the tumor was complete, the wound surface was superficially desiccated with an electric plate and the cavity loosely packed with vaseline gauze sprinkled with boric acid powder. The patient left the operating room in good condition.

Postoperatively there was only a slight rise in temperature, little pain and no other complaint. Convalescence was uneventful. The patient was out of bed on the fourth day and was discharged to the surgical clinic twelve days after the operation, at which time the wound was clean and covered with healthy granulations. Some areas of the frontal bone and orbital portion of the zygoma, affected by coagulation, had begun to sequestrate. (Figs. 2A and B.)

On July 30th, the patient was readmitted to the hospital for plastic repair. The previously operated areas were carefully débrided of excess granulation and the frontal and maxillary sinuses were again curetted and additional bits of bone and soft tissue removed for further microscopical examination, in an effort to be reasonably certain that all the tumor had been eradicated.

A pedicled forehead and scalp flap containing the temporal artery, with a hairy portion to replace the eyebrow, was prepared from the temporofrontal region (12 by 10 cm.). The right canthus was reconstructed after a Thiersch graft from the thigh was sutured to the undersurface of the skin flap to replace the missing mucous membrane of the nose. The denuded area on the parietal and temporal region was covered with a skin graft from the thigh. The

* From the Tumor Clinic, Department of Surgery, New York Post-Graduate Medical School and Hospital, Columbia University. Presented before the Section of Ophthalmology, New York Academy of Medicine, May 20, 1940.

A B

C

FIG. 1. A, extensive recurrent basal cell carcinoma of nose, cheek and orbit with involvement of the paranasal sinuses; B, lateral view, showing right inner canthus and lids involved; C, lateral view showing involvement at the left side.

A B

FIG. 2. A, three weeks after coagulation, the wound was covered with healthy granulation, excepting bones affected by coagulation; B, lateral view of defect resulting after radical operation. Remnants of the frontal, ethmoidal and maxillary sinuses can be seen.

FIG. 3. Pedicled temporal flap containing the temporal artery, with a hairy portion to replace left eyebrow, covers the defect. Denuded temporal area was covered with skin grafts.

A

B C

FIG. 4. A, pedicled flap divided and restored; final result; B, final result, left lateral view; C, final result, right lateral view.

nose was loosely packed with vaseline gauze. The skin flap, which was sutured to the defect by interrupted black silk sutures, did not show any discoloration on the application of a loose head bandage. Recovery was uneventful. The patient was discharged on the seventh day after this operation. (Fig. 3.) The revision and final stage was undertaken three months later under local anesthesia. The pedicle flap was divided and the residual portion restored to its original location. (Figs. 4A, B and C.) The postoperative course was uneventful. The patient was discharged to the clinic on the third day after the operation. He had been hospitalized for twenty-one days.

The pathological examination, No. 15944-73392, showed basal cell carcinoma with considerable growth activity. Specimens from the second operation showed only granulation tissue.

The patient has been well since the operation; he has had no complaints and there is no evidence of recurrence over a follow-up period of six years. A prosthesis was subsequently made by Dr. Alexander Sebo to replace the lost eye. (Fig. 5.)

There is some retraction of the left nostril for which correction was refused by the patient.

This case is presented to demonstrate the effectiveness of a radical operation by electrosurgery followed by plastic reconstruction. Electrocoagulation has in our experience proved to be a satisfactory means of eradicating such advanced tumors.[1] The coagulated tumor tissue is readily differentiated from uninvolved tissue during this type of piecemeal removal. It is possible, therefore, to determine the extension of the malignant process and to remove enough surrounding uninvolved tissue to prevent recurrence. Such a procedure, in selected cases, has distinct advantages over classical resection, especially when the extension of the tumor cannot be determined with sufficient exactitude necessary for block resection.[2]

Plastic reconstruction was performed early for economic reasons, but only after we had proved by biopsies that the tumor had been removed. We agree with other surgeons, who advocate reasonable delay

Fig. 5. Patient with artificial eye; no evidence of recurrence over a follow-up period of six years.

before plastic reconstruction in cases of recurrent and advanced cancer, to allow control of possible recurrences. In general a delay of six months to one year, with frequent biopsies from suspicious areas is practiced by us. Exceptions from this rule are permissible if a surgeon of sufficient experience has removed the tumor by wide excision through the uninvolved tissues far beyond its extension regardless of the consequent defect and disfigurement. However, if a tumor has extended close to vital structures and a wide radical removal is not possible, plastic repair had better be delayed.

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NEUROFIBROMA WITHIN A LIPOMA OF THE NECK*

CASE REPORT

CHARLES H. HALLSON, M.D. AND PETER MARCUSE, M.D.
Chief Surgical Resident, Jefferson Davis Hospital — Assistant Pathologist, Jefferson Davis Hospital
HOUSTON, TEXAS

THOUGH the presence of lipomas and neurofibromas in the same person has been reported (Adair, Pack and Farrior,[1] Alsberg,[2] Stout[3]), there seems to be no record of neurofibromatous tissue occurring within a lipoma. It seemed, therefore, justified to report the following case.

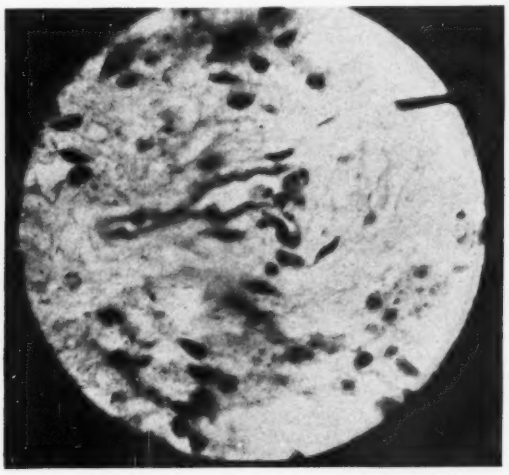

FIG. 1. High power view of a section taken from the structure in the center of the lipoma, showing fine, interlacing fibers and elongated cells with pointed processes (hematoxylin-eosin).

CASE REPORT

The patient, a fifty-four year old, colored female, came to the Out-patient Department Surgical Clinic of Jefferson Davis Hospital because of a mass on the right side of her neck. She had always been in good health, but had had some fibroids removed several years ago. Nine years ago the patient noticed a soft nodule on the right side of her neck. This mass continued to grow slowly but never caused the patient any pain.

Physical examination revealed a well developed, well nourished, middle aged, colored female. Examination of the circulatory and respiratory system was negative. Neurological findings were normal, as were abdominal and pelvic palpation. The skin showed no lesions except for a nodule, approximately 1.5 cm. in diameter, located in the scalp of the occipital region, just to the left of the midline. This tumor was moderately firm, slightly movable against the underlying tissue, firmly adherent to the skin and non-tender. The main finding on physical examination, was a tumor, approximately 8 cm. in diameter, involving the right side of the lower neck and part of the right shoulder. This mass was soft, non-tender, movable against the underlying tissue, but not against the skin. The regional lymph nodes were not enlarged.

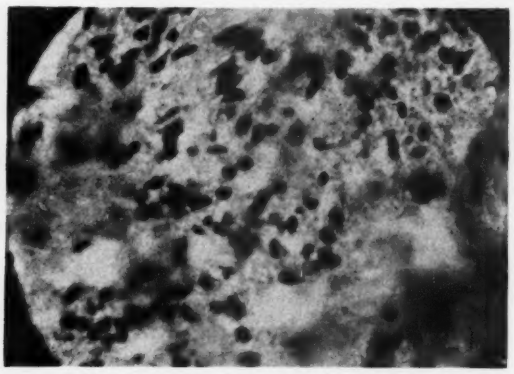

FIG. 2. High power view, showing character and arrangement of cells in the neurofibromatous tissue. Note palisading in the upper part of the field (hematoxylin-eosin).

Routine laboratory examinations were essentially negative. A Kolmer and Kline test were negative. However, there was a report of a four plus Kline in 1939, since which time the patient had had antiluetic treatment.

The tumor of the neck was diagnosed as a lipoma and excision was performed. The gross description of the specimen was as follows:

"The specimen consists of an elliptical piece of colored skin, 6.0 × 2.0 cm. A mass of adipose

* From the Surgical Division and the Department of Pathology, Jefferson Davis Hospital, Houston, Texas.

tissue, approximately 7.0 cm in diameter, is adherent to the skin. This mass is soft and friable, subdivided by fibrous septa, and is enclosed in a thin, translucent capsule. Cut surface is sulphur yellow, homogenous, except for a nodule, 1.0 cm in diameter, which is located in the center of the mass. This nodule is of moderately firm, non-friable consistency, appears light pinkish gray and homogenous. It is indistinctly delimited from the surrounding tissue and projects slightly above the level of the cut surface. The appearance of the skin is not remarkable."

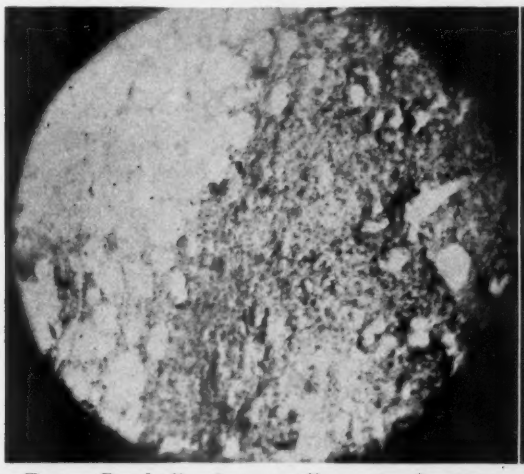

Fig. 3. Borderline between lipoma and neurofibromatous tissue (hematoxylin-eosin, low power).

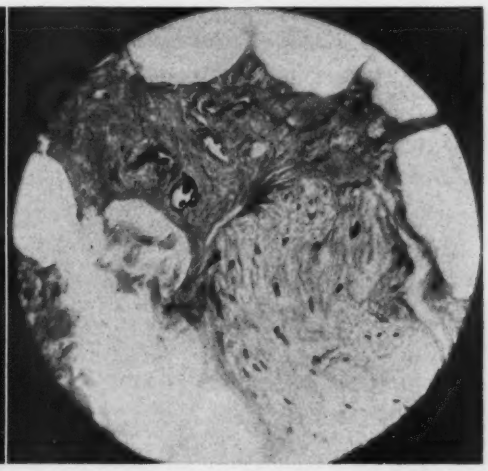

Fig. 4. Section from a lipoma of the axilla. showing a branch of a peripheral nerve within a fibrous septum (hematoxylin-eosin, high power).

Microscopic examination of the main mass showed a typical picture of adult fat. Sections taken from the nodule that was found in the center of the mass showed the characteristic appearance of a neurofibroma. There were numerous thin strands of interlacing fibers. Arranged between these were elongated, fairly regular cells with ovate nuclei and long pointed processes. (Fig. 1.) The cells were arranged in rows and in whorls and, in places, palisading was noticeable. (Fig. 2.) The nuclei were regular, fairly dark and there was no increased mitotic activity. The nodule was not encapsulated, and near its periphery the tissue was interspersed with fat cells. (Fig. 3.) Several well developed blood vessels were seen and the fibers and cells appeared arranged in a concentric manner around these vessels.

A block from the specimen was sent to Dr. A. P. Stout, Department of Surgical Pathology, College of Physicians and Surgeons, New York, who reported that this was a neurofibroma in the center of a lipoma. Slides were also sent to Dr. William Boyd, Department of Pathology, University of Toronto, Canada, who confirmed that the section showed neurofibroma intermingling with fatty tissue.

The small nodule from the scalp was removed later, and gross as well as microscopic examination proved it to be a sebaceous cyst.

The postoperative course was uneventful; the wound healed satisfactorily and there has been no evidence of recurrence for several months after the operation.

COMMENT

The tumor can be classed as a fibrolipoma, with the fibrous component being restricted to the center of the growth. This type of fatty tumor is rare. In Geschickter's[4] series of 622 lipoid tumors there were eighteen cases of fibrous or embryonic lipoma.

In the case under discussion the fibrous element appears to be of nerve sheath origin. This brings up the interesting problem of a possible connection between lipoma and neurofibroma, and between lipoma and peripheral nerves, a question that is usually discussed with reference to multiple lipomas. As Ewing[5] says: "The occurrence of multiple symmetrical lipomas has suggested to many a connection with the peripheral nerves." Adair, Pack, and Farrior[1] also point out that lipomas and

neurofibromas have certain similarities and that association of lipomas with nerve fibers in the subcutaneous tissue has been observed.

Neurofibromas have been found with lipomas in the same case (Adair, Pack and Farrior,[1] Alsberg,[2] Stout[3]). However, even the authors who consider the two growths to be related have found no definite histologic evidence to prove the relationship (Hogue[6]). Moreover, all the observations were made with regard to neurofibromatosis and multiple lipomatosis and are not readily applicable to single tumors.

The case here presented shows that association of neurofibromatous with lipomatous growths can occur. Nerve fibers have been traced into lipomas (Alsberg[2]). A lipoma of the right axilla, removed from a thirty-four year old colored female at Jefferson Davis Hospital, also shows clearly small branches of peripheral nerves in the fibrous septa between the various lobes. (Fig. 4.) It appears possible that a neurofibroma might arise from one of these septal nerve branches without having any etiological connection with the lipoma. The location of the neurofibroma in the center of the growth and its indistinct delimination is suggestive of a neurogenic origin of the lipomatous component but is no conclusive proof.

From the clinical point of view the case under discussion shows the importance of careful gross and microscopic examination of all lipomas. Fibrolipomas are classed among the recurrent lipomatous tumors by Geschickter,[4] and even malignant change is not infrequently observed. The general tendency to consider lipoma an absolutely innocent tumor may easily lead one to overlook other elements in a lipomatous growth.

SUMMARY

A case of lipoma containing neurofibromatous tissue is presented. Though the two growths were closely associated in this case, there is no definite proof as to the neurogenic origin of the lipoma. The presence of nerve fibers in lipomas and the occasional association of neurofibromatosis with multiple lipomas are discussed. The importance of a careful examination of all lipomas is stressed.

We are indebted to Dr. A. P. Stout, Department of Surgical Pathology, College of Physicians and Surgeons, New York, and to Dr. William Boyd, University of Toronto, Canada, for examining the specimen and for permitting us to quote their opinion.

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CONGENITAL TERATOMA OF THE THYROID

E. H. MUNRO, M.D. AND RICHARD WALDAPFEL, M.D.
Surgeon, St. Mary's Hospital
GRAND JUNCTION, COLORADO

TUMORS of the newborn have aroused the interest of the practitioner, obstetrician, and pathologist since the early days of medicine. The uncommonness of their occurrence and development explains this interest sufficiently.

The type of tumor reported in this paper—teratoma—occurs most frequently in the ovary and in the testicle and next most frequently at the two ends of the original infolding of epithelium in the primitive embryo, namely, in the sacrococcygeal region and in the bronchogenic region. Teratomas of the thyroid gland, however, are very rare. Russell and Kennedy,[1] in a report of a case published in 1913, state that in twenty-two annual volumes of this journal only one reference has been made to it (Hewetson[2] 1903). Pusch and Nelson[3] in a clinical revision up to 1935 could collect only twenty-eight authentic cases from the entire world's literature, the first case dating back as far as 1691. Another case was published since this comprehensive article by Potter[4] in 1938. Most of the cases reported have been stillborn or in a prematurely delivered fetus. Almost without exception those born alive have not survived more than a few days. Tammann, of the Clinic of Goettingen, in 1925 reported a case with a tumor 4 cm. in diameter, successfully operated upon.

There has never been a satisfactory explanation as to the origin of these tumors. The most understandable theories are perhaps: (1) Separation of a totipotent blastomere in the early stage of cell cleavage and its migration to a point where it later develops, and (2) some kind of twinning with overgrowth of one twin.

As to the occurrence in the thyroid, it would seem possible that a fertilized polar body could have been included in the primitive infolding of the epithelium in the branchogenic region which later forms the thyroid primordium and migrates down from the second branchial arch through the hyoid, past the larynx to the upper portion of the trachea. In the many complex changes in this region, the thyroid anlage meets with many bizarre accidents and aberrant thyroid glands result in the nasopharynx in, on or beneath the tongue, in the wall of a thyroglossal cyst, prelaryngeal, intratracheal, intra-esophageal, supra- or subclavicular,—or in the posterior triangle of the neck. The occurrence of such a variety of accidents to the thyroid in the embryo lends argument to the theory of inclusion of a polar body or of some other multipotent cells from the primitive germ layers within tissues undergoing invagination or fusion.

Because of the rarity of these cases and our limited experience with them, it is desirable that new cases be reported whenever found. Every new report is apt to furnish more details heretofore unknown, and will contribute to our knowledge of the pathogenesis of these formations.

CASE REPORT

K. L. was four weeks of age when his mother brought him for the first examination. She reported that it was a normal birth and K. was the third child. The others are healthy and normal. Neither parent was goitrous. The father's sister and mother's mother had goiters. When K. was born, the parents noticed a slight swelling of the left side of his neck and some breathing difficulties in certain positions. They thought it would disappear, but it did not. On the contrary, it seemed to increase in these four weeks. The breathing was worse in feeding and sleeping on the right side. Sometimes the

baby really turned blue and became limp and unconscious.

The first examination showed a slightly cyanotic, somewhat undernourished child with a left sided tumor of the neck. (Fig. 1.) It was the size of a fist, was covered by normal skin, and belonged apparently to the left lobe of the thyroid gland with which it moved upward in swallowing movements. The tumor itself was not movable nor separable from the thyroid gland. No tenderness or inflammation was present.

Nose and pharynx were normal. The laryngoscopy showed a normal larynx which, perhaps as a whole, was slightly dislocated to the right side. There was a definite inspiratory stridor noticeable mainly when the baby's head was turned to the right side; in this position the baby was slightly cyanotic. Otherwise, the baby appeared normally developed. The *x*-ray examination showed a slight displacement of the trachea to the right side with little narrowing of its lumen in the uppermost portion. The tumor was non-opaque, but within its limits several small densities were discernible.

Fig. 1. Baby at first examination. Tumor of left thyroid lobe.

Fig. 2. Baby four months after operation. Tumor completely gone, child excellently developed and free of any tumor symptoms.

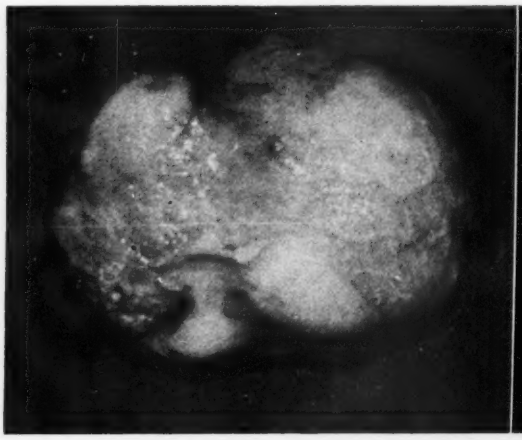

Fig. 3. Tumor removed at operation; nodular surface.

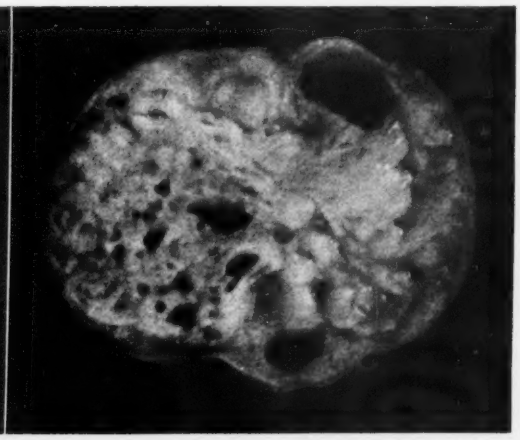

Fig. 4. Cross section of tumor. Left side hard, containing bony parts; right side spongy; numerous cavities; fibrous capsule surrounding entire tumor.

The clinical and *x*-ray examination led to the diagnosis: Unusual nodular goiter, perhaps fetal adenoma.

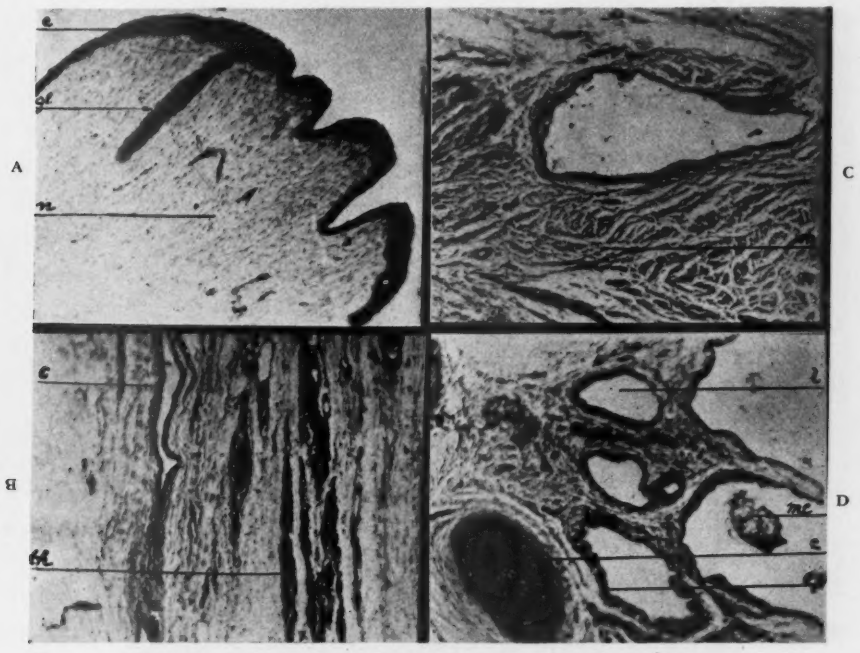

FIG. 5. Microscopical sections through tumor; complete absence of thyroid tissue except in B. A, embryonic nerve tissue (*n*) covered by squamous epithelium (*e*); gland tubule (*gl*) lined with squamous epithelium. B, part near capsule; *c*, capsular vein. There are several rows of atrophic thyroid acini, the only place in the tumor where thyroid tissue could be found. C, striated muscle (*m*) around a cavity. D, lumina (*l*) lined with columnar epithelium (*ep*) and containing mucus (*mc*); hyaline cartilage near by (*c*). The whole formation is suggestive of an abortive attempt at bronchus and lung formation.

Operation was recommended on account of the breathing difficulties. The parents wanted to take the baby home first, but were advised to watch the baby's breathing and to report instantly in case it became worse. They came back two weeks later when they discovered the baby's condition slightly worse. The stridor was continually noticeable and the swelling had somewhat increased in size.

Operation was performed on August 5, 1942. Everything was ready for an instant tracheoscopy and introduction of a narrow tube through the larynx into the trachea at a moment's notice and for a tracheotomy as well should signs of suffocation appear during the operation. After administering the first few drops of ether, the breathing seemed to become worse and still looked critical during the incision of the skin, but it improved considerably, against expectation, when the tumor was grasped with the forceps and pulled away from the trachea. Keeping up this pull, the operation could be finished uneventfully without resorting to tracheoscopy or tracheotomy. The operation consisted in removing the entire tumor from the left lobe of the thyroid gland, to which it definitely belonged and by which it was surrounded in its whole circumference. After splitting a thin layer of thyroid tissue, what appeared the capsule of the tumor was struck and the tumor could be removed in its entirety with its capsule in blunt dissection. It seemed attached to the surrounding tissue only near the trachea. Bleeding was inconsiderable. The breathing became instantly normal after separating the tumor from the trachea and remained so through the postoperative course of healing, which occurred uneventfully and per primam. (Fig. 2.)

The removed tumor (Fig. 3) measured about 2½ by 1½ inches and showed a smooth but nodular surface in some of its portions. The specimen was fixed in formalin for a few days and then cut in two. It showed a very unusual picture on its cross section. (Fig. 4.)

Within a thin fibrous capsule numerous cavities could be seen and between them tissue of different consistency and structure. The knife felt some hard resistance like ossifications which belonged to the left part of the tumor in Figure 4; this part was made up of a tough fibrous tissue basis and could be differentiated microscopically from a right lobular part which showed more spongy appearance and seemed gelatinous in its consistency.

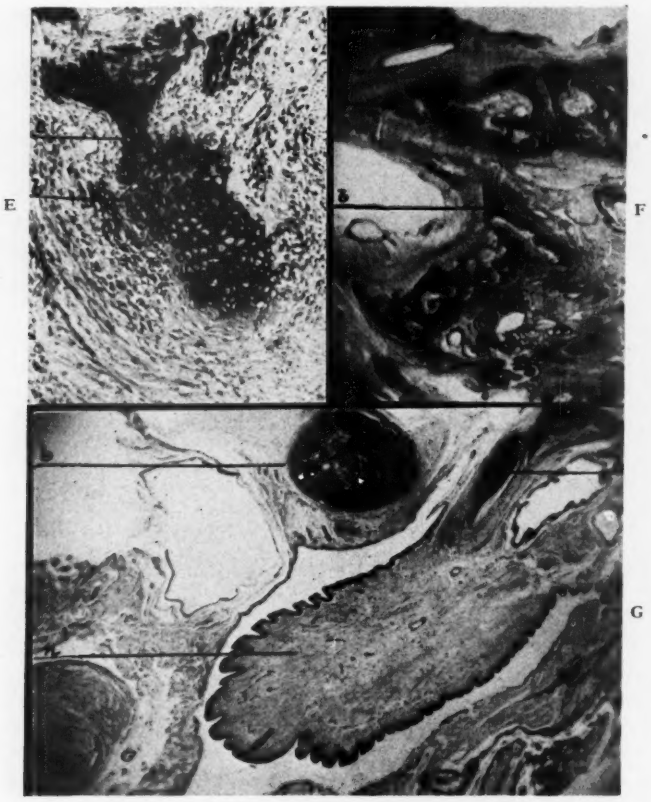

FIG. 6. E, bone formation (*b*) of intercartilaginous (*c*) type. F, bone formation (*b*) of intramembranous type. G, bud-like projection (*n*) of nerve tissue into a cavity. The bud is covered by squamous epithelium and contains bone in its root and near by (*b*).

The microscopic examination was made from several portions of the tumor and showed complete absence of thyroid tissue except in a small area of the capsule where several rows of atrophic thyroid acini were present. (Fig. 5B.) No colloid material was seen in any part of the various sections.

The greater bulk of the tumor was made up of mostly heterogenous tissue elements with embryonic nerve tissue in the foreground (Figs. 5A and 6G) which seemed almost the matrix of the whole tumor. A net of lumina lined with columnar epithelium and containing mucus, suggested embryonic bronchial formation (Fig. 5D); occurrence of foci of cartilage confirmed this suggestion and the whole section may well represent an abortive attempt at formation of a lung. Gland tubules lined with squamous epithelium showed the character of the epidermis of the embryo. (Fig. 5A.) An island of hyaline cartilage could be seen, bone formation of intercartilaginous type (Fig. 6E) and of intermembranous type (Fig. 6F and G), striated muscle. (Fig. 5C.) Pigmented columnar epithelium and isles of dark staining melanin represented very likely embryonic retina. There were many bud or polyp-like projections of connective and nerve tissue into the cavity spaces. (Fig. 6G.) Nowhere did the various elements form a definite structure nor arrange themselves to form an organ.

COMMENT AND SUMMARY

We are concerned here with a growth of the thyroid gland made up of elements

entirely different from the normal constituents of thyroid tissue.

The various elements of the tumor showed the following origin: (1) Ectodermal: nerve tissue, squamous epithelium, pigmented epithelium, hair follicles, sweat glands; (2) mesodermal: cartilage, bone, muscle, connective tissue, and (3) entodermal: columnar epithelium of tracheobronchial character.

This survey shows that all three germinal layers were represented in the tumor and the tumor, therefore, must be regarded as a real congenital teratoma or embryoma. Clinically it caused symptoms of suffocation soon after birth which could be eliminated by surgical removal of the tumor.

The rarity of the case justifies this report. The fact that this observed case is one of the very few which has been found and diagnosed in the living, and has been operated upon and cured, makes it still more worth while recording.

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INTRAMEDULLARY tumours are usually malignant, and are commonly gliomatous. Other varieties include tuberculoma, cyst, and endothelioma, which have probably originated from invagination of the pia mater which lies in the posterior spinal sulcus, or else have become embedded in the cord.

HYPOGLYCEMIA AND ABDOMINAL PAIN

CAPTAIN MERLE J. BROWN
MEDICAL CORPS, ARMY OF THE UNITED STATES

SPONTANEOUS hypoglycemia is important surgically since it may produce abdominal pain that must be differentiated from surgical lesions. In definition, Allan considers hyperinsulinism is manifested by hypoglycemia and the symptoms which accompany the fall of sugar content to a lower level. However, hypoglycemia can occur from other causes and does not by any means invariably indicate hyperinsulinism.

Harris, in 1924, two years after discovery of insulin by Banting, first called attention to hyperinsulinism. Since this time much literature has accumulated on the subject. The surgical literature contains many articles with reference to islet cell tumors as a cause of hypoglycemia. The combined experiences of the surgeon and the internist have shown that not all cases of hypoglycemia are due to pancreatic tumors or malignancy. Conn has published a comprehensive etiologic classification of the spontaneous hypoglycemias. Of the two main groups of cases, organic and functional, it is believed that we are most concerned with the functional type in this paper.

West and Kahn have stated that hypoglycemia and consequent overfunction of islands of Langerhans, without tumor formation, is occasionally seen in the newborn, especially in those of diabetic mothers, and occasionally in early childhood, but has been reported infrequently as a definite finding in adults. These authors considered that opposing endocrine secretions, disturbed liver glycogen function, central nervous system lesions, and faulty dietary habits contribute to functional spontaneous hypoglycemias. Harris wrote that patients with diabetes have given histories of hypoglycemic symptoms. He suggested that there may exist a family tendency as in diabetes. Allan stated that although hyperinsulinism related to known organic disease is rare, it is thought by some that many of the cases of hypoglycemia represent functional hyperinsulinism. Whether this is true or not, conditions which require consideration of hyperinsulinism are seen not uncommonly. The author agrees with this idea, since in being alert to the possibility of hypoglycemia as a cause of abdominal pain it had to be considered in the differential diagnosis of pain of intra-abdominal lesions. In a period of approximately one year, ten patients were found to have abdominal pain due to hypoglycemia which was controlled by dietary means.

The symptoms of hypoglycemia are variable, depending upon the degree of decrease of blood sugar. The great bulk of symptoms occurring in hypoglycemia may be considered neurologic in origin. Abdominal pain as a result of hypoglycemia has been previously reported. Harris stated that pain of hyperinsulinism has simulated appendicitis, gallbladder disease and duodenal ulcer. The pain is usually exaggerated during attacks, though it may be present more or less constantly. Also tenderness may be elicited over the pancreas on deep palpation. This pancreatic tenderness is most easily elicited by deep palpation of the epigastrium above the umbilicus and just to the left of the midline. Harris considered that pain and tenderness are most frequent when a pancreatic tumor exists. Sandler wrote that pain in hypoglycemic patients may be generalized or localized. The localization of pain may be in any portion of the abdomen. He stated that hypoglycemia has a tendency to stimulate the same group of neurons in the vagal nucleus and the particular segment of the gastrointes-

tinal tract (including the biliary tract) innervated by these neurons undergo strong contraction, which may even be tetanic. Allan stated that variability and diversity of the symptoms make the clinical picture appear complex, but recognition of the disorder is simplified by a common characteristic, particularly, that the symptoms tend to occur when the stomach is empty and subside after eating or drinking sugar-containing foods. The pain of hypoglycemia may simulate the anginal pains of heart disease.

There may be a confusion of abdominal pain of hypoglycemia where associated lesions such as acute hepatitis, malignant lesions of the gastrointestinal tract, starvation states, cachexia, and liver glycogen dysfunction exist. Brown and Harvey have reported hypoglycemia in "smoke" drinkers. These patients may have abdominal pain. Coller and others deduced that when a glycosuric patient is found to have a low fasting blood sugar level the disturbance in carbohydrate metabolism is most likely to be on the basis of hepatic disease. He stated that the glucose tolerance test with normal or low fasting blood sugar levels rising during the first and second hour to higher levels than normal, and finally falling to hypoglycemic levels during the third, fourth, and fifth hours, is probably indicative of dysfunction of the liver. Reports have appeared in the literature stressing the fact that hypoglycemic attacks occur in some women in the first days of menstruation. Therefore, confusion of menstrual cramps with hypoglycemic pain may occur. Hypoglycemic states may accompany or result from renal glycosuria.

In the treatment of hypoglycemia, since most cases are not associated with organic pancreatic disease and do not fulfill the indications for surgery as outlined by Whipple, other methods must be sought. Conn has discussed the use of a high protein, high fat, and low carbohydrate diet. Since it has been biochemically shown that about 58 per cent of protein is oxidized as carbohydrate, a slow absorption of glucose results. If large amounts of carbohydrate, readily absorbed, is ingested, insulin secretion is stimulated in excess of the amount required to utilize the sugar intake. The excess glucose required to neutralize the insulin must be drawn from blood sugar and liver and muscle glycogen. This cycle of events results in a vicious circle so that glycogen stores never reach capacity for compensating blood losses. It is obvious from this reasoning that carbohydrate diet is not successful in treatment of hypoglycemia.

In making clinical interpretations of hypoglycemia, the blood sugar levels, as set forth by Harris, were used: (1) mild cases 75 to 65 mg. of blood sugar, (2) moderate cases 65 to 55 mg., and (3) severe cases 55 mg. and below.

The following case reports are of patients found in approximately one year of search. Five patients had an appendectomy performed. Three of these were operated upon after the clinical impression of hypoglycemia was established, while two were operated upon before. One of these two was operated upon by another surgeon. This patient had an incomplete inguinal hernia at the time he appeared for examination and study. The hernia was not repaired for the pain was relieved by dietary means. The appendices showed low grade infection.

CASE REPORTS

CASE 1. Mrs. E. T., age thirty-four years, had had severe attacks of nausea, vomiting, and epigastric and right lower quadrant pain. She had noted exacerbation of symptoms six to eight hours after overeating of carbohydrate foods. After attending a party on one occasion at about the age of twenty-five years, she was operated upon for "appendicitis." Her postoperative convalescence was stormy with severe nausea and vomiting. These attacks promptly recurred and another medical opinion was given that attacks were due to her menses. About ten years ago she had a convulsion and unconsciousness following overeating of sweet foods. A medical opinion of brain tumor was given at this time,

and that nothing could be done. Following a pregnancy six years ago she required six months for convalescence. During the last two to three years her symptoms have become worse. Additional symptoms such as tremors (dropping dishes), headaches, dizziness, weakness, extreme tiredness, craving for candy, hunger, and flushing have developed. The attack which led to the diagnosis followed about six to eight hours after a large Thanksgiving dinner. The patient had a severe nausea and vomiting with epigastric pain which was not controlled by ordinary medication. She was hospitalized and given 1000 cc. of 10 per cent glucose in saline intravenously. In two hours all symptoms had disappeared and the patient wanted to go home.

Physical examination gave no positive findings except a slight, non-localized, epigastric tenderness. Temperature was 98.4°F. Laboratory findings showed a blood sugar of 88 mg. per 100 cc. of blood (after the glucose had been given). A fasting blood sugar was then found to be 65 mg. per 100 cc. of blood and the urine showed 1.25 per cent sugar. A glucose tolerance test (six hours) with urinary sugar test was done to give the following results:

Specimen	Blood Sugar per 100 Cc.	Urinary Sugar
1—30 minutes	100 mg.	1.65 per cent
2—2 hours	109 mg.	3.50 per cent
3—3 hours	77 mg.	1.16 per cent
4—4 hours	83 mg.	.77 per cent
5—5 hours	50 mg.	.30 per cent
6—6 hours	61 mg.	.10 per cent

In view of the persistent glycosuria together with the low blood sugars, the patient was considered to have renal glycosuria which contributed to the loss of blood sugar. This patient had an irresistible craving for candy and was unable to pass a candy counter when shopping without buying and eating large amounts of candy. She was placed on a diet of protein 120 Gm., fat 150 Gm., and carbohydrate 120 divided into four meals daily. In about four weeks she was symptom free and the glycosuria which was constant became intermittent. Against the wishes of female patients, she gained thirty-five pounds. However, she considered the weight gain more tolerable than the symptoms which she had had for years.

Case II. E. A., a white male, twenty-eight years of age, was an asthenic type of person who had complained of gastrointestinal symptoms for six months. He had epigastric pain, cramp-like in character, associated with bloating, belching, vomiting, and spells of diarrhea. He had been seen elsewhere on several occasions and had been given gastrointestinal *x*-ray studies. Although he was told that no ulcer could be demonstrated, he was given ulcer therapy without relief. Two months before appearing for this study his pain had become constant with radiation of pain to the right lower quadrant accompanied by severe diarrhea and vomiting.

Physical examination was negative except for tenderness in the epigastrium and right lower quadrant. He was considered clinically to have a chronic recurrent appendicitis. Appendectomy was done and the patient was symptom-free for three months. Laboratory study of blood sugars showed a fasting sugar of 88 mg. per 100 cc. of blood. Glucose tolerance test (six hours) showed first hour 62.5 mg., second hour 75.0 mg., third hour 80.0 mg., fourth hour 111.0 mg., fifth hour 66.0 mg., sixth hour 63.0 mg. per 100 cc. of blood. The symptoms were reproduced during the glucose tolerance test.

The patient was considered to be hypoglycemic and was placed on a diet of protein 120 Gm., fat 140 gm., and carbohydrate 120 gm. The diet was divided into four meals daily. The patient maintained his diet and gained weight for about six weeks. He then began to indulge heavily in alcoholic beverages and symptoms promptly recurred. He developed dizziness, weakness, sweating, fatigability, precordial pains, fainting, and tremors.

Case III. P. W., a white male, asthenic type, thirty-two years of age, complained of dizziness, weakness, fatigability, and epigastric pain. There were attacks of nausea and vomiting. His epigastric pain was most intense when his dizziness was most severe. He had been examined and treated by twenty doctors in the past two or three years with no relief of symptoms. Perspiration was profuse at times. The patient had lost ten pounds in the past two years.

Physical examination showed only slight tenderness over the pancreatic area. There were no palpable masses or enlargement of solid organs. The fasting blood sugar was 71 mg. per 100 cc. of blood. Glucose tolerance showed first hour 132 mg., second hour 58 mg., third hour 54 mg., fourth hour 56 mg., fifth

hour 61 mg., and sixth hour 63 mg. per 100 cc. of blood.

The clinical impression was spontaneous hypoglycemia as the cause of the abdominal pain. The entire symptom complex of which the patient complained was reproduced during the glucose tolerance test. The patient was placed on a high protein and fat and low carbohydrate diet. He failed to return so that it is impossible to express the results in this case.

Case IV. F. J. H., a white male, well developed and nourished, age thirty-four years, complained of chronic constipation, anorexia, and recurrent pain in the right lower quadrant. About one year previously he had had an appendectomy for a chronic appendicitis. He felt fine for about six months and then began to have a feeling of bloating, dizziness, nervousness, inability to concentrate at work, and headaches.

Physical examination showed only a small, easily reducible, indirect, inguinal hernia and an appendectomy scar. The hernia was not tender to palpation. Laboratory studies of blood and urine were normal. However, the fasting blood sugar was 70 mg. per 100 cc. of blood. Glucose tolerance (six hours) gave the following results: first hour 159 mg., second hour 158 mg., third hour 88 mg., fourth hour 43 mg., fifth hour 46 mg., and sixth hour 60 mg. per 100 cc. of blood.

Clinically, this patient was considered to have spontaneous hypoglycemia. He was advised of the findings and placed on a diet high in protein and fat but low in rapidly absorbable carbohydrates. He was told that if pain was not relieved by this procedure a repair of the hernia would be indicated. After three weeks of dietary care all symptoms were gone.

Case V. G. O. T., a white male, asthenic type, age thirty years, related the story that he had a "strep" throat and had been given sulfanilamide. Two months after this he began to have epigastric burning pain. The pain was severe when he was hungry. The pain was also worse in midmorning and afternoon. His bowels were constipated and bloating and flatulence were severe. The pain also projected to the right lower quadrant and was accompanied by nausea. The patient admitted drinking whiskey in large amounts for relief of the pain. He had been to other doctors and was given therapy for "ulcers" without relief.

The physical examination showed moderate epigastric tenderness and severe right lower abdominal tenderness. There were no abdominal rigidity or masses. Rectal (digital) examination produced acute right pelvic tenderness. The white blood count was 8,350. Blood amylase was 83; fasting blood sugar was reported as 75 mg. per 100 cc. of blood.

On the basis of physical findings, an appendectomy was done. The appendix was of the chronic obstructive type.

During the postoperative convalescence a glucose tolerance test (four hours) was done with the following results: first hour 157 mg., second hour 132 mg., third hour 93 mg., and fourth hour 50 mg. per 100 cc. of blood.

The appendectomy relieved the patient of lower abdominal pain and tenderness. The epigastric findings were improved and relieved in about three weeks when the patient was placed on a high fat and protein and low carbohydrate diet.

Case VI. M. M., a white, single, female, asthenic type, age twenty-three years, complained of recurrent pain in the right lower quadrant, belching, bloating, and indigestion. She suffered a loss of appetite and had lost ten pounds in about one month. The recurrent abdominal symptoms had been present for about four years. Weakness, headaches, and palpitation occurred.

Physical examination showed acute tenderness in the right lower quadrant and a Trichomonas vaginalis. The vaginitis was successfully treated but the abdominal pain continued to recur. Her weight had dropped to eighty-seven pounds. Laboratory studies showed white blood count 9,850 with other counts negative. Cystoscopy and *x*-rays showed a normal urinary tract; basal metabolism rate −7, fasting blood sugar 80 mg. per 100 cc. of blood.

The glucose tolerance test (six hours) gave first hour 128 mg., second hour 75 mg., third hour 61 mg., fourth hour 66 mg., fifth hour 68 mg., sixth hour 71 mg. per 100 cc. of blood.

An appendectomy was performed through a right transrectus incision. No other pathological findings were present on exploration. The appendix was of a chronic obstructive type. The patient was placed on a high protein diet and all previously existing symptoms cleared. When the patient relaxed her dietary vigilance, symptoms soon recurred.

Case VII. M. B., a white male, twenty-one years of age, well developed and nourished with some obesity, had complained of epigastric soreness and pain in the right lower quadrant

associated with nausea for two or three months. He claimed that he was hungry most of the time. There had been spells of dizziness, precordial pain, and no relief of symptoms by food intake. He indulged heavily in alcoholic beverages during week ends.

Examination showed moderate tenderness over the entire epigastrium with moderate tenderness in the right lower quadrant. Blood pressure was 140 systolic and 88 diastolic with a pulse rate of 80 per minute. Graham-Cole study revealed a normal functional gallbladder. White blood count was 10,800, with the remaining blood picture being normal. The fasting blood sugar was 81 mg. per 100 cc. while the glucose tolerance test gave the following readings: first hour 93 mg., second hour 100 mg., third hour 75 mg., fourth hour 73 mg. per 100 cc. of blood.

An appendectomy was done and the pathological study demonstrated a subacute appendicitis. This operative procedure with diet of extra protein and fat controlled all symptoms. The patient's alcoholic habits and neglect of diet brought a return of gastrointestinal symptoms. Dietary vigilance always produced relief of his symptoms. This patient enlisted in the Army Air Corps and has been unable to qualify as a pilot.

Case VIII. A. S., a white male, age thirty-five, somewhat obese, was a heavy drinker at times but he denied any indulgence in the present attack. He stated he had passed out at work, and two days later again on the street at night to produce bruises about his face. He was found by the police and was placed in jail over night in the belief the patient was drunk. He complained of having recurrent epigastric pain, nausea at times, dizziness, and loss of appetite.

Examination showed him to be obese and weighing 198 pounds. There was slight epigastric tenderness. He had recovered from a hernia operation three months before and presented a well healed scar. Blood pressure was 150 systolic and 70 diastolic, while the pulse rate was 88, regular and normal in volume. The blood and urine findings were within normal limits. Fasting blood sugar was 77 mg. per 100 cc. of blood. A glucose tolerance test showed: first hour 150 mg., second hour 125 mg., third hour 75 mg., fourth hour 69 mg., and fifth hour 65 mg. per 100 cc. of blood.

A restriction of alcoholic consumption and diet of extra protein and fat controlled all the symptoms. After relief of his symptoms he followed his diet poorly, but he could always produce a reversal by resuming his controlled diet.

Case IX. A white female, age twenty-eight, well developed and nourished, tending to be obese, complained of attacks of marked dizziness, headaches, tremor, and generalized abdominal pain associated with indigestion. She had been told two years before that she had low blood sugar and that her basal metabolism was within normal limits.

Physical examination demonstrated no positive findings to explain the symptoms. There was no local abdominal tenderness. A fasting blood sugar was 81 mg. per 100 cc. of blood. The glucose tolerance test showed: first hour 100 mg., second hour 112 mg., third hour 50 mg., fourth hour 40 mg., fifth hour 47 mg., sixth hour 51 mg. per 100 cc. of blood. The glucose tolerance test produced symptoms of dizziness, tremors, drowsiness, and abdominal pain about three hours after administration of the glucose.

This patient was placed on a diet high in proteins and fats, and carbohydrates were reduced to a minimum. On this regime she was able to control all symptoms.

Case X. E. S., a white male, age forty-two, asthenic and nervous type, had had precordial pain recurring and three years previously had an attack with syncope. He was attended by a doctor in another city who had performed several electrocardiographic readings which were not considered indicative of heart disease according to the patient. At the time he appeared for examination he complained of drowsiness, weakness, lack of ambition, and general abdominal pain. He was unable to keep up with his duties as manager of a large chain store business. He had given up this responsibility in the belief that he was suffering from heart disease.

Physical examination gave no evidence of disease. The heart size was normal to percussion and on auscultation there were no murmurs. Blood pressure was 110 systolic and 68 diastolic. His pulse volume was normal, while the rate was 72 with a regular rhythm.

Laboratory findings were: urine negative, red blood count 4,700,000, white blood count 7,700, hemoglobin 13.2 Gm. (86 per cent). Blood chemistry results were: fasting blood cholesterol 228 mg. per 100 cc. of blood; fasting blood sugar 88 mg. per 100 cc. of blood;

glucose tolerance test first hour 150 mg., second hour 84 mg., third hour 63 mg., fourth hour 70 mg., and fifth hour 77 mg. per 100 cc. of blood. Electrocardiogram showed no evidence of heart disease. Basal metabolism was −4.

Gastric analysis (fractional) showed no free hydrochloric acid and a combined acids of 8. There was no change after alcohol but with histamine stimulation free hydrochloric acid reached 65 and the combined acids of 15.

All symptoms were controlled by high protein and fat diet. He was also given thyroid extract (1 gr.) daily. The patient has returned to his managerial position.

COMMENTS

These ten cases definitely demonstrate that abdominal pain in hypoglycemias occurs when surgical intervention is not indicated. These reports show that patients with recurring abdominal pain require differential diagnostic procedures to rule out appendicitis, gastric or duodenal ulcers, cholecystitis, hepatitis, chronic pancreatitis, and other abdominal lesions. Patients in the age group of twenty to forty years, in whom operative procedures have been done with no relief or recurrence of symptoms, should be studied for hypoglycemia. The author believes that the syndrome of hypoglycemia is far more common than is usually suspected since it has been possible to find ten patients in the short time of approximately one year of search.

CONCLUSIONS

1. Patients having recurrent abdominal pain in the absence of positive acute lesions of the abdomen should be studied for hypoglycemia as a cause of the pain.

2. Spontaneous hypoglycemias not due to pancreatic tumors can be controlled by a diet high in protein and fat but low in carbohydrates.

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A SIX MONTHS' TUBAL PREGNANCY*

CASE REPORT

SANFORD KAMINESTER, M.D.
Associate Visiting Obstetrician and Gynecologist, Greenpoint Hospital

AND

ROBERT MCN. MITCHELL, M.D.
Resident Obstetrician and Gynecologist, Greenpoint Hospital

BROOKLYN, NEW YORK

TUBAL gestations developing for twenty-four weeks or beyond are still of sufficient interest and rarity to permit reporting. Although cases simulating this one are found in the literature, there are interesting features which might well be recorded.

CASE REPORT

The patient, a thirty-one year old colored woman, was first seen at the Greenpoint Hospital out-patient prenatal clinic on November 17, 1942, at which time she was six months pregnant. She presented herself because she had not felt fetal life for the past two weeks.

There had been one previous pregnancy which terminated in a spontaneous delivery of a normal 10 pound infant eleven years previously. Menstruation had begun at the age of thirteen, the interval was twenty-eight days, and duration five days with no dysmenorrhea. At the age of fifteen and again at twenty-two years, the patient had had "tube trouble." This was the only significant fact in her previous history.

On examination the findings were as follows: Weight 169½ pounds, blood pressure 130/78; abdominal mass the size of a 7 months' gestation, no fetal heart heard, no fetal movements made out.

Urinalysis was negative. The Wassermann and Kline reactions were also negative. *X*-ray examination was reported as follows: "The fundus of the uterus extends to the upper margin of the third lumbar vertebra. A fetus is present in the transverse position with the head on the right. The bones of the skull are not sufficiently well visualized for description but the fetus itself appears to be collapsed. This is suggestive of fetal death."

The patient was followed in the prenatal clinic at weekly intervals, the only complaints being abdominal tenderness and a certain amount of mental depression as a result of the realization that the fetus was dead. The blood pressure became slightly elevated, reaching 158/98 but it soon fell and maintained a level of about 140/84. Urine remained normal and weight remained at 168 to 170 pounds.

On December 8, 1942, the patient reported that she had had slight vaginal spotting but no pain. She was admitted to the hospital. The findings were essentially as recorded before. On December 10, 1942, a vaginal examination was done. The cervix was uneffaced and not dilated. There was no evidence of rupture of the membranes. No presenting part was felt through the cervix. No bleeding occurred during or following this examination. In view of the fact that the fetus was dead and the uterus was not increasing in size, induction of labor was attempted with estrogenic substance followed by pituitrin.[1] This was repeated several times. On December 25th, the first febrile reaction was noted. A hyperpyrexia developed which persisted for twenty-eight days, the highest point reached being 102°. The origin of this fever was attributed to the vaginal examination which was thought to have stirred up a latent infection. Laboratory findings during this time were, white blood cells 19,800, sedimentation time 18 mm. in 10 minutes, urine clear, blood pressure 142/90.

X-ray examination taken on December 31st showed the same findings as on the previous examination.

In view of the febrile course which had ensued following vaginal examination, it was deemed inadvisable to institute any surgical procedure. Since medical induction of labor had failed, it was decided that the patient was to be allowed to proceed with no treatment until she delivered spontaneously.

During the next fifty-three days, during which the patient was followed in the out-

* From the Department of Obstetrics and Gynecology, Greenpoint Hospital.

patient department at two-week intervals, she felt well and was afebrile. She lost thirteen pounds in weight and the abdominal mass receded until it was the size of a five months' gestation. On March 30th, *x*-ray examination showed essentially the same findings as on the other examinations except for the fact that the uterus appeared smaller.

On May 6, 1943, the patient was readmitted. The abdominal mass was at the level of the umbilicus. Bimanual examination revealed the true state of affairs for the first time. The uterus could be made out to the right side of the pelvis and anteverted. It was a little larger than normal in size. On the left, one could feel the abdominal mass which was definitely not connected with the uterus. The diagnosis of extrauterine pregnancy was made and laparotomy performed under gas-oxygen ether anesthesia.

At operation, the uterus appeared normal in size, shape and position. The right tube and ovary were adherent to the posterior wall of the uterus and the right tube had been converted into a small hydrosalpinx. Above the uterus and almost in the midline of the abdomen was a firm mass measuring 10 by 15 by 20 cm. This mass was found to arise from the left tube. No left ovary could be identified. The omentum was adherent to the mass but these adhesions were fine and easily broken down. The mass was removed by clamping and cutting the left broad ligament which was then sutured. The right adnexa were not disturbed.

The patient made an uneventful recovery and was discharged on the eleventh day.

The pathological examination was made by Dr. Rosa Aronoff whose report follows: Gross: The specimen consists of an oval mass measuring 14 by 10 cm. in diameter. The external surface is mottled yellowish-grey and red-blue, is partly smooth, glistening and partly opaque, contains some slender as well as broad membranous tags. In one place incorporated in this mass is a short segment of a tubular structure about 2½ cm. in length and 0.5 cm. in diameter. The cut surfaces contain a large cavity occupied by a fetus of about six months' gestation. The wall of the cavity ranges from 0.1 to 3.0 cm. in thickness, is composed in the wide portion of soft opaque mottled gray-yellow and red tissue surrounded by a narrow band of closely set, firm strands. The soft outer zone widens for a distance of 4 cm., to a thickness of 1 cm. and contains an occasional small cyst 0.3 cm. in diameter filled with clear watery

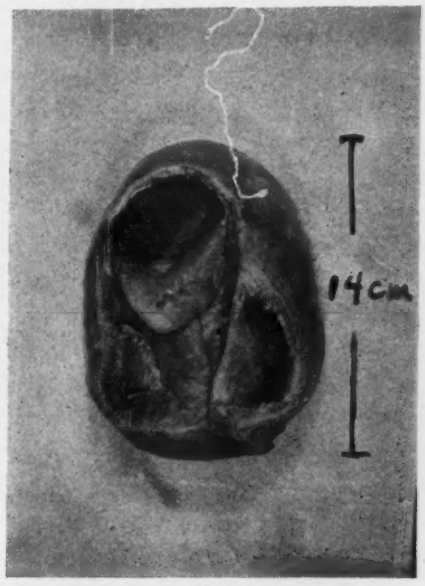

Fig. 1. Tube with window cut away to reveal fetus and placenta.

fluid. Five sections are taken for microscopic study.

Microscopically, in sections from the sac surrounding the fetus, the inner surface is irregular and made up of degenerated and in some places organizing chorionic villi merging with and extending into the underlying vascularized wall which is composed of parallel, longitudinal bundles of smooth muscle fibers. These are spread apart and infiltrated, especially about the vessels, by a moderate number of small round cells, large mononuclears, rare eosinophils and neutrophile polynuclears. Some areas are infiltrated with extravasated blood. Many of the imbedded vessels are thick-walled and have narrow lumina. In one place overlying the tube and partly fused with it is a zone of characteristic ovarian stroma containing an occasional follicular cyst and several corpora albicantia. A section from the short tubular segment presents the isthmic portion of the tube with intact coats and slight diffuse and focal infiltration by small round cells.

Diagnosis: Advanced tubal pregnancy of about six months' gestation.

COMMENTS

Several interesting features present themselves: First, the absence of abnormality in

the menstrual history for seven months of this gestation. In reviewing the histories of such cases presented in the literature this seems to be a common finding, more often true than not. There is no inkling of abnormality gleaned from the menstrual history to lead to the suspicion of an extrauterine gestation. Why this patient had painless spotting at seven months remains conjectural.

Second, the patient had two episodes of "tube trouble." Pelvic inflammatory disease has long been associated with the etiology of ectopic pregnancy. There seems to be a definite relationship found in this instance. One episode of pelvic inflammation developed at the age of fifteen years and the second developed at the age of twenty-two years, two years after termination of her first pregnancy. At the operating table gross evidence of previous pelvic inflammation involving the right tube and ovary was found.

Third, there is the patient's history of a relative sterility. The use of contraceptive devises was denied yet no second pregnancy developed for a period of eleven years. It is possible the first "tube trouble" involved the left side leaving the right tube and ovary free to function normally which it apparently did. Shortly after her first baby the right tube and ovary became involved in the second infection and there followed a period of relative sterility.

Fourth, there was a marked degree of hypertrophy and dilatation of an organ not ordinarily considered very distensible. Schummann's[2] suggestion in attempting to explain the extraordinary ability of the tube to dilate and hypertrophy seems plausible in this case. The placenta was located in the inferior margin of the ampullary portion of the tube, a site of rich blood supply and a site in contact with the elastic mesosalpinx, which would permit greater hypertrophy of the tube wall during placentation. Hence, there would be less danger of perforation by the eroding syncytial cells covering the elongated anchoring villi. Since the ampullary region of the tube is the largest and most distensible portion, the fetus in turn would be permitted to continue its growth distally along a line of least resistance and not be hampered in its development by a too great lack of space.

Fifth, the presence of a flattened and incorporated left ovary and its suspensory ligament in the outer layer of the ovisac was another interesting feature.

Sixth, there was an apparently normal development of a six months' fetus. The mother first sought medical advice because of the cessation of fetal activity. The roentgenograms suggested a stillborn fetus developed to six and one-half to seven months. The succeeding roentgenograms recorded a gradual diminution in size of the infant. The fetus was not removed from the ovisac, hence accurate measurements could not be taken. The specimen was turned over to the Long Island College of Medicine.

Seventh, the patient's general well being was significant. Prior to her hospital admission her antenatal course was not suggestive of toxemia but following hospitalization and manipulation she did run a low grade septic fever which subsided and the remainder of her course was uneventful. The patient appeared mentally and physically well, at the time of surgery.

Eighth, the failure of multiple attempts at medical induction was striking. The patient suffered no apparent deleterious effects. The failure of these procedures which have been shown to be highly successful in inducing labor on women having intrauterine stillborn fetuses suggests extrauterine gestation.

We wish to express our appreciation to Dr. T. S. Welton, Director of the Obstetrical and Gynecological Service at Greenpoint Hospital, for granting permission to publish this case.

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TWISTED OVARIAN CYSTS IN CHILDREN

CASE REPORT

J. A. FOWLIE, M.D.
SANTA ROSA, CALIFORNIA

OVARIAN cyst with torsion of the pedicle in children is an uncommon condition; only about one hundred twenty-five cases have been reported in the past one hundred years. Actually, about 97 per cent of ovarian cysts occur in adults instead of children.[2] The literature contains such interesting cases as an ovarian cyst in a seven months premature infant, and torsion of an ovarian cyst in a ten days old baby (Busch).

Abt[1] states that 60 per cent of various tumors of the ovary in children are malignant. Stevens[9] reports that the majority of ovarian cysts in children are dermoid and that they are four to five times as common as simple ovarian cysts with twisted pedicle. Ladd and Gross[5] claim that 60 per cent of ovarian tumors and cysts in children are malignant, but that 20 per cent are dermoid and 20 per cent are simple cysts, i.e., that dermoid and simple cysts occur with equal frequency in children. A simple cyst is filled with clear fluid while a dermoid contains hair, teeth, nails, sebaceous material and other ectodermal products.

The majority of twisted ovarian cysts in children occur on the right side for some obscure reason, and because of this right-sided preponderance the diagnosis is usually mistaken for an acute appendicitis, with or without abscess formation depending upon whether or not a mass can be palpated. Indeed, it is sometimes impossible to differentiate between an acute appendicitis with or without perforation and a twisted ovarian cyst in children as the history and physical findings are often very similar. Other conditions that enter into the differential diagnosis are intussusception, urolithiasis, mesenteric adenitis and Meckel's diverticulitis. Rectal examination will often times be very helpful in arriving at the correct diagnosis, and the importance of doing a rectal examination, especially when the diagnosis is in doubt, cannot be too strongly emphasized. It is a procedure that we are too prone to neglect in children. This is clearly shown in the case about to be reported; both myself and my colleague failed to do a rectal examination. Had we done so, we may have arrived at the correct diagnosis as the cyst was located deep in the pelvis and would have been easily palpable. *X*-ray evidence is also of value sometimes especially in the case of dermoids after the urinary bladder is emptied, otherwise the cyst may be mistaken for a full bladder.

There may be symptoms of a vague character consisting of nausea and vomiting preceded by vague abdominal ache for a few days with one or more severe attacks of sudden abdominal pain lasting for a few hours, each severe attack seemingly coinciding with a tighter twist of the pedicle.

Surgical intervention for ovarian tumors and cysts in children should be undertaken as soon as the diagnosis is made, because of the high frequency of malignancy in children and also to forestall possible torsion of the pedicle.[7]

The following case which came under the observation of the author illustrates a typical case.

CASE REPORT

D. S., age ten years, was first seen June 26, 1943, at 6:00 P.M. complaining of severe pain in the right loin, crampy in character, and of about two hours' duration. She had had a dull ache in the right lower quadrant for several

days, but on the day she was first seen it became much more intense. She had vomited once or twice following the acute onset of the pain.

FIG. 1. Twisted ovarian cyst with distal half of right Fallopian tube.

Past illnesses and family history were irrelevant. The bowels were regular. There were no renal symptoms. She had no cough and her menses had not yet started.

Upon physical examination, her temperature was normal, pulse 100, respirations normal. The throat and chest were normal. The abdomen was soft; no masses were felt and there was absolutely no tenderness even on deep palpation. Rectal examination was not done. The urine was normal and the blood count showed red cells to be 3,648,000; white cells, 17,950; neutrophiles 90, hemoglobin 72 per cent.

On consultation with another physician, his findings in the abdomen were essentially the same. He, too, failed to do a rectal examination. It was decided to keep her under observation for twelve hours withholding everything by mouth. In the morning, since she felt much better, she was allowed to leave the hospital and to take fluid by mouth.

The following morning I was called to see her again as the mother said that she was worse than ever. It seems that after leaving the hospital, she felt much better all that day and evening; she also had had a good night sleep. However, in the morning her pain returned more severe than ever. On physical examination, her fever was 99°F. by mouth, pulse 112, and the lower half of her abdomen was rigid and very tender. Rectal examination was not done. A diagnosis of acute appendicitis was made and the colleague who had seen her before now confirmed that diagnosis. He also neglected to do a rectal examination.

An emergency operation was performed as soon as arrangements could be made. Under ethyl chloride-ether anesthesia, a McBurney incision was made. The abdominal cavity was full of free bloody fluid. The appendix could not be immediately located. On exploration, a large cystic mass was palpated deep in the pelvis and was delivered into the wound with slight difficulty due to adhesions after first enlarging the incision. This mass turned out to be a right cystic ovary, the size and shape of a large kidney, with the pedicle twisted. After untwisting the pedicle, the distal half of the right tube was found to be gangrenous due to its involvement in the twist. The pedicle and distal half of the tube were clamped, cut, and the ends transfixed. The uterus and left tube and ovary were normal. The appendix was now easily found; it was normal and was removed. The abdomen was closed in layers without drainage.

Recovery was uneventful except for a bloody liquid stool on several occasions which was not investigated further and she was discharged on the twelfth postoperative day.

The pathologist's report was as follows: Gross specimen: a formalin fixed ovary and attached Fallopian tube which have a combined weight of 170 Gm. The ovary is bean-shaped and possesses the following measurements: length 9.8 cm., width 4.8 cm., and thickness 5.0 cm. Upon longitudinal cut section, it is found that there has been a marked hemorrhagic extravasation into the entire parenchyma. Discernible through out the cortex are occasional cysts which measure up

to 0.8 cm., and which are filled with clear fluid.

There has also been an extensive hemorrhagic extravasation of the Fallopian tube. A cross section of the pedicle reveals a thrombosis of the veins.

Histological examination: Sections reveal a marked hemorrhagic extravasation of the parenchyma. No tumor is present. The red blood corpuscles are well preserved, but densely grouped. A section across the pedicle shows the veins to be filled with recent thrombus. The diagnosis is strangulation, ovary and Fallopian tube; hemorrhage, ovary and Fallopian tube, marked.

SUMMARY

Ovarian cyst with torsion of the pedicle in children is a rare condition and is usually mistaken for acute appendicitis when it occurs on the right side.

The importance of rectal examinations in children is emphasized especially in obscure abdominal conditions.

Surgical treatment is simple and the results are very good.

An accompanying case report illustrates a typical case.

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APPENDICITIS IN SITUS INVERSUS TOTALIS*

CASE REPORTS

COLONEL MANFRED U. PRESCOTT AND CAPTAIN RICHARD W. ZOLLINGER
MEDICAL CORPS, ARMY OF THE UNITED STATES

FALIRICIUS,[1] in 1600, reported a case of reversed position of the liver and the spleen. This was the first case of transposition reported in the literature in man; however, Aristotle recorded observations in two instances of transposed organs in animals. Petrius Servius,[2] in 1615, recorded a case of transposition at autopsy and it was not until 1824 that Krichenmeister[1] accomplished the diagnosis in a living patient. Vehsemeyer[3] demonstrated the condition by means of *x*-ray. After this the incidence of the condition became established because of the ease with which the diagnosis could be made with laboratory aid.

The incidence of this anomaly has been quoted by many authors. Sherk,[2] in 1922, observed the condition ten times in 347,000 hospital admissions at the Mayo Clinic from 1910 to 1922. Willis,[4] in 1925, reported three cases in 10,000 hospital admissions. LeWold[5] recorded twenty-nine cases in 40,000 *x*-ray studies or one in approximately 1,400 cases. In 1926, in a review of the literature, Cleveland[6] was able to collect 400 cases. Twelve years later Larson[7] in a similar review estimated that approximately seventy-five cases had been added since the report of Cleveland in 1926. From an autopsy standpoint Rosler[8] found transposition in three cases in 22,402 autopsies. Adams and Churchill[9] state that situs inversus occurred in twenty-three of 232,112 patients admitted to the Massachusetts General Hospital.

In admissions to the Station Hospital, Truax Field, three cases of transposition were found. Two of these were diagnosed by physical examination and corroborated by *x*-ray. One of these was further proved by operation. The third case was discovered on routine chest *x*-ray examination and gastrointestinal *x*-ray studies. There have been 7,072 chest *x*-rays accomplished at this station and the last case mentioned above is the only case accidentally discovered.

CASE REPORTS

CASE 1. On October 28, 1942, the patient was admitted to the Station Hospital. He was forty-three years of age and his complaints were sore throat, cough, and chills of two days' duration. The rest of the history was not pertinent. The essential physical findings were redness of tonsils and nasopharynx. Examination of the heart revealed the apex beat to be within the mid-clavicular line on the right side and otherwise normal. The blood pressure was 126/70. Abdominal examination revealed liver dullness in the left upper quadrant and tympany suggesting the presence of the stomach in the right upper quadrant. The rest of the physical examination was normal.

The *x*-ray findings showed normal heart and lungs in situs inversus. A barium enema showed that the same condition existed abdominally.

The patient's convalescence was uneventful. Before his discharge from the hospital he was advised as to the abnormal position of his viscera. He was told that if he ever had pain in the abdomen he should advise his attending physician that his appendix was on the left side.

On February 4, 1943, he was again referred to the hospital. This time he was complaining of epigastric pain which had localized to the left lower quadrant. On admission he was able to advise the surgeon on call of the left-sided position of the appendix. This was of great aid in diagnosis. Physical examination revealed localized tenderness associated with muscle spasm and rigidity in the left lower quadrant

* From the Surgical Service, Station Hospital, Truax Field, Madison, Wisconsin.

at a point which was analogous to McBurney's point on the right side.

Laboratory findings on this admission were:

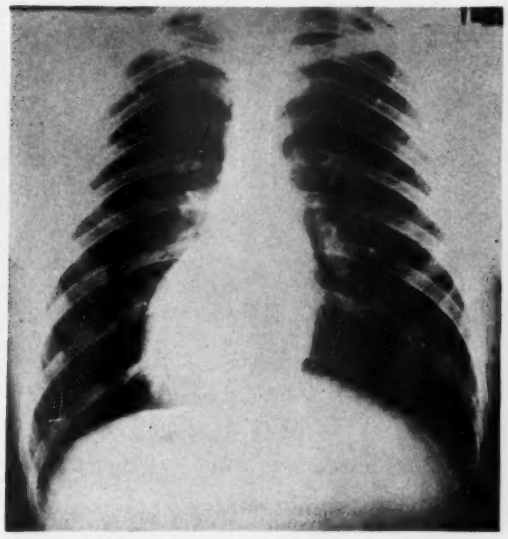

Fig. 1. Chest in Case 1 showing dextrocardia.

Red blood count 4,320,000; white blood count 10,150; hemoglobin 80 per cent. The differential blood count showed 71 per cent polymorphonuclears and 27 per cent lymphocytes. The urine examination was normal.

He was explored through a left McBurney incision under spinal anesthesia and the appendix was removed.

The pathological diagnosis of this appendix was "acute ulcerative and suppurative appendicitis with fecalith, and fibrous obliteration of the terminal end of the appendix."

His convalescence was completely uneventful.

Case II. A twenty-three year old white male was admitted to this hospital April 4, 1943, complaining of a swelling in the left femoral region of seven years' duration. When the pain in the femoral region became severe there was associated nausea and vomiting. Physical examination revealed a right-sided heart which was otherwise normal and a soft, tender, cough-propelled mass in the region of the left femoral ring. *X*-ray examination of the chest and abdominal viscera with barium enema established the diagnosis of situs inversus totalis. During the course of his hospital stay the hernia was repaired.

Case III. A twenty-one year old white male, was admitted to the hospital on March 28, 1943, complaining of pain in the right side of his chest. The patient stated that during a routine examination while in high school the examining physician informed him that he had "heart disease" and was not to climb steps or

Fig. 2. Barium enema (postevacuation film) showing left-sided position of the appendix in Case 1.

exercise. The chest pain dates from this examination. The pain was described as a dull ache made worse by deep breathing. He complained of some dyspnea on exertion. The physical examination was negative except for the following findings: The apex beat of the heart was both visible and palpable just inside the right mid-clavicular line. The rhythm was regular. A systolic murmur without thrill was present at the apex. The murmur was obliterated by holding the breath in complete inspiration or expiration. There was no diastolic murmur. Liver dullness was noted in the left upper quadrant of the abdomen. Barium enema showed on *x*-ray a situs inversus coli. Chest plate revealed a dextrocardia. Electrocardiogram was essentially negative. The medical service concluded that the pain was not cardiac and that the systolic murmur was functional. He was discharged to duty on April 4, 1943, with a diagnosis of situs inversus viscerum totalis.

SUMMARY

1. Three cases of situs inversus totalis are presented. These represent the incidence in 15,374 hospital admissions, or one in every 5,124 admissions.

2. A case of left-sided, acute appendicitis is presented which had been previously diagnosed and substantiated by *x*-ray findings at this hospital.

3. The fact that the patient had been advised of his intestinal congenital anomaly was a distinct aid when his surgical condition arose.

4. It is of value to remark that the symptoms and signs in the case presenting appendicitis were at no time referable to the right side.

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TREATMENT of a contused bone consists in rest and cold applications, which exert a vaso-constricting effect, and thus limit oozing. If infection threatens, fomentations are applied. Oedema or fluctuation necessitates an incision down to the bone in order to reduce tension or, if suppuration has occurred, to allow the exit of pus.

The brief excerpts in this issue have been taken from "A Short Practice of Surgery" by Hamilton Bailey and R. J. McNeill Love (H. K. Lewis & Co. Ltd.).

SALPINGO-OOPHORITIS AND APPENDICITIS IN PATIENT WITH CONGENITALLY ABSENT VAGINA, UTERUS AND LEFT ADNEXA*

CASE REPORT

WALTER J. REICH, M.D. AND MITCHELL J. NECHTOW, M.D.

Attending Gynecologist and Director, Gynecological Division of the Fantus Clinics, Cook County Hospital

Clinical Associate, Gynecological Division of the Fantus Clinics, Cook County Hospital

CHICAGO, ILLINOIS

THE following case is reported because of the rarity of its type:

CASE REPORT

This white female, aged thirty-one years, has been married for nine years. She was about 5 feet 1 inch in height, weighed 125 pounds; her breast development and other female characteristics were normal. She was Italian, her husband, Bulgarian, and she was apparently happy.

She had consulted several doctors to ascertain why she had not menstruated in her adolescence and early twenties. She was told that she had "some gland trouble" and needed "shots." And the patient was given these "shots" for several months, but she did not menstruate.

Pelvic examination revealed that this patient had no external vaginal orifice, but only a dimple at the site of the introitus. Rectally, no female genitalia were made out.

For the two months she experienced pain in the right lower quadrant which would come and then disappear, but on November 17, 1942, the previous recurrent pain became localized over McBurney's point. She vomited once that afternoon and appeared subacutely ill.

In giving her past history she told us of a thyroidectomy at the age of sixteen years, and that bronchial asthma had been present for several years. She had one sister, who was apparently normal, and four brothers, who were in good health. Her mother died of pulmonary tuberculosis. Her father was living and well.

On physical examination we found an old, wide, irregular thyroidectomy scar. Her blood pressure was 120/70; pulse, 100; temperature, 99.4°F.; respiration, 28. The chest presented many musical râles, but no fluid or consolidation. The abdomen was slightly distended and there was slight muscle spasticity in the right lower quadrant. No real rigidity was made out. The site over the McBurney point was definitely tender, so that the patient complained and cried when the area was palpated. The peristaltic sounds were present and slightly faster than normal.

Rectal examination revealed the presence of exquisite tenderness over the cecal area and the right adnexal zone, although no definite masses were discernible.

Laboratory findings were:

White blood cells	12,100
Neutrophils	79%
Segmented	76%
Band	3%
Eosinophils	1%
Lymphocytes	20%
Red blood cells	4,610,000
Hemoglobin	96%
	17.5 Gm.

Urine was essentially negative.

Because of the aforementioned complaints and findings a preoperative diagnosis of acute appendicitis was made. However, it was decided to make a midline incision to explore the pelvis thoroughly.

Complete absence of the uterus and the left adnexa was found at operation. However, the fossa of the right iliac bone revealed the presence of a deep fold of peritoneum which grossly resembled a remnant of the right broad ligament and which formed into a fold; and in this fold were found the ovary and tube, the appendix overlying the latter. The tube and the ovary were adherent by fine but firm

* From the Norwegian American Hospital and Cook County Graduate School of Medicine.

adhesions; the ovary was thickened, fibrotic, and contained multiple follicular cysts, also one corpus luteum cyst which was bleeding. fibrous throughout and has some small cysts up to 8 mm. size. Adherent to the ovary is the fimbriated end of the tube and the fimbriae

FIG. 1. Note the absence of uterus and left adnexa.

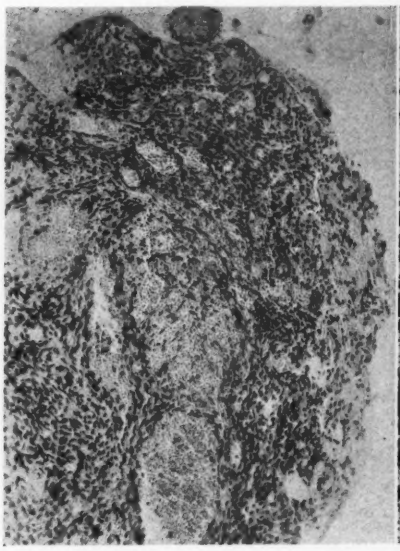

FIG. 2. Section of the ovary. × 215.

FIG. 3. Section of the tube. × 90.

There were many small peritoneal cysts on the fimbria and on the tube proper. The latter showed gross evidence of inflammatory disease. The appendix was free but fibrotic and injected. The above mentioned structures were removed and the abdomen closed.

The pathological report from the laboratory, reported by Dr. H. R. Fishback, is as follows:

Ovary, 4 by 2 by 1 cm., has a thick, greyish-yellow fibrous capsule. On section it is quite are shortened and fibrous and inclose small cysts up to 8 mm. size filled with clear fluid.

Appendix: 4 cm. long by 5 mm. thick. It has a fat meso-appendix. On section the wall is 2 to 3 mm. thick and fibrous and the lumen stenosed.

Microscopic section of the ovary shows a hemorrhage surrounded and infiltrated by numerous young granulosa cells on a fibrous tissue base. Sections of the fimbriated ends of

the *tube* show the tube wall to be congested and somewhat thickened by fibrous tissue. The fimbriae are swollen and blunted. There is one thin-walled cyst lined by flattened epithelium which has a very thin fibrous wall.

Diagnosis: Hemorrhagic corpus luteum of the ovary; follicular cysts; fibrous change in the fimbriated ends of the Fallopian tube, fibrous changes in the appendix.

This patient had an uneventful recovery and in ten days left the hospital. She has been perfectly well since.

Comment. This case is interesting from several different aspects. The question of improper treatment for amenorrhea needs only a word to emphasize the value of complete pelvic examination and to warn one not to rely on hearsay.

The explanation for the inflamed tube and ovary in the absence of an exterior vaginal orifice is a matter of deduction. Unquestionably, the inflammation was of endogenous origin. The question whether the recurrent salpingo-oopharitis caused secondary appendicitis by contiguity or vice versa remains as such. But do we not observe clinically that even upper respiratory infections such as tonsillitis may cause mesenteric adenitis? And that pneumococcus peritonitis following acute pneumonitis is believed to be metastasized via the Fallopian tube? And why may it not cause tubo-ovarian inflammation, be it of lymphogenous or hematogenous route?

We do not know the exact mechanism of spread, but clinically, we do see these organs become inflamed and causing symptoms in spite of the absence of an external vaginal orifice.

OCCLUSION OF INFECTED PATENT DUCTUS ARTERIOSUS WITH CELLOPHANE

FRED R. HARPER, M.D.* AND MURRAY E. ROBINSON, M.D.
Diplomate of the American Board of Surgery
DENVER, COLORADO BURLINGTON, COLORADO

As more patients with patent ductus arteriosus are being operated upon successfully, it is becoming obvious that the ordinary types of ligature material are inadequate to maintain occlusion of a patent ductus arteriosus. This is particularly true of the infected cases. It is, therefore, the purpose of this paper to offer a better type of ligature material. Cellophane fulfilled the requirements of a satisfactory ligature material in the case we are reporting.

The idea of using cellophane was suggested to us by Dr. Richard Meade as the result of a letter received by him from Dr. Robert Gross. The principle was based upon the experimental work of Pearse. Holman, in his discussion of Pearse's paper, first proposed that the cellophane might be a suitable ligature material for the occlusion of a patent ductus arteriosus.

Graham, Gross and Jones, Dolly and Bullock have all expressed the opinion that ligation alone with the ordinary types of ligature material is inadequate to obtain complete permanent obliteration in all cases of patent ductus arteriosus. This is particularly true of the infected cases with large irregularly shaped vegetations within the lumen of the ductus arteriosus. The authors know of one case in which the patient had to be operated upon a second time because ligation with silk ligatures at the first operation failed to accomplish complete and permanent obliteration of the ductus arteriosus.

The case we are reporting was a particularly favorable one to determine the value of cellophane as an occluding material. In the first place, the patient was an adult woman, age twenty-eight years. In the second place, she had had subacute bacterial endocarditis and endarteritis for at least seven months. Both of these factors tend to make the likelihood of failure or recurrence much greater than in young patients who are not infected. Furthermore, the postoperative course of the patient clearly demonstrated that braided silk ligatures alone would have failed to accomplish a permanent occlusion of the ductus arteriosus.

CASE REPORT

The patient was a poorly nourished white woman who weighed only eighty-five pounds. She was twenty-eight years of age, married but had no children. The diagnosis of patent ductus arteriosus had been made when she was only three years of age. She had been a semi-invalid all of her life. For seven months prior to being seen by us she had had symptoms of superimposed, subacute, bacterial endocarditis and endarteritis. The presence of the infection was evidenced by increasing fatigue, daily fever of 102° to 105°F., night sweats, cough, and loss of ten pounds of weight. One of the outstanding features of her case was the repeated showers of emboli which caused pain in the chest, hemoptysis and hematuria. On examination she was found to have a generally enlarged heart with a loud "machinery" murmur which was systolic at the apex, systolic and diastolic in the pulmonic area. Her blood pressure was 110/40. Repeated blood cultures before operation revealed non-hemolytic, non-viridans streptococcus. The blood Wassermann test was negative.

She was given several blood transfusions and sulfonamide therapy prior to operation. The operation was performed under intratracheal cyclopropane anesthesia. The incision was

* Dr. Harper is now a Major in the Medical Corps.

made through the second intercostal space anteriorly. The mediastinal pleura was incised parallel to the recurrent laryngeal nerve and that nerve was followed down to the ductus arteriosus. The ductus arteriosus was about 2 cm. in diameter. A very definite pulsation could be felt by placing a finger over the ductus arteriosus which helped in identifying it. After carefully dissecting away the connective tissue, so that the ductus arteriosus was adequately exposed, two No. 8 braided silk ligatures were placed around it and tied securely. A strip of cellophane (DuPont No. 300 P.T.) which had been folded four times so that it was one-fourth inch in width, was loosely wrapped around the ductus arteriosus and the ends tied together with a fine silk ligature. The cellophane had been sterilized by soaking in mercury oxycyanide solution for twelve hours prior to the operation. No attempt was made to close the mediastinal pleura. The incision in the chest wall was closed tightly without drainage.

The patient's postoperative course was very interesting. Immediately after the operation her blood pressure changed from 110/40 to 90/70, and by the next day was 126/90. The murmur disappeared at once. By the third postoperative day her temperature returned to normal and remained less than 100°F. for the following fourteen days. For seven months prior to the operation she had had a daily fever of 102° to 105°F. By the end of two weeks following the operation the murmur became distinctly audible again. On several occasions her temperature rose to 101°F., and she again had pain in her chest and hemoptysis suggestive of showers of emboli. A course of sulfonamide therapy given at that time was not effective in controlling the infection.

When two months had elapsed from the time of the operation, the murmur which had reappeared over the ductus area was becoming less audible and the patient's general condition was improving. After two and one-half months had elapsed from the time of the operation the murmur had completely disappeared again. Her temperature at that time was normal, her pulse was 92, and her blood pressure was 120/84. From that date on, she improved steadily. She gained weight from eighty-five pounds to 127 pounds during the year following her operation. At the time of the last report, which was received one year and four months following her operation, she had become pregnant, was feeling perfectly well, and was doing her own house work.

COMMENT

The case which we have reported would seem to be a fair case to test a method of occlusion of a patent ductus arteriosus. As Turoff has pointed out, in older patients and in patients who have had endocarditis and endarteritis for a long time, the chances of a cure are less favorable. Our patient was twenty-eight years of age which should be considered in the older age group for this operation. Furthermore, she had had evidence of a severe endocarditis and endarteritis for a period of at least seven months which is considered a long duration for the infection, particularly when it was as severe as it was in this case. Therefore, the case could not be considered as an easy one in which to obtain a complete cure.

That the cellophane was the main factor in bringing about the obliteration of the ductus arteriosus and eventual complete recovery of the patient is demonstrated by following the postoperative course. She showed immediate improvement following the operation while the ductus was being temporarily occluded by the silk ligatures. However, at the end of two weeks the cardiac murmur had returned as had many of her symptoms. This was the time at which the silk ligatures were no longer effective in maintaining the complete occlusion. Had the cellophane not been used, the murmur and the symptoms undoubtedly would have continued to increase in severity and to have persisted. The disappearance of the murmur at two and one-half months marked the time at which the ductus was finally completely obliterated and the patient cured. This final occlusion of the ductus we interpret as being due to action of the cellophane.

Pearse demonstrated on dogs that cellophane is an extreme tissue irritant which causes an intense reaction. The process causes a steady progressive constriction of

the vessel and an eventual obliteration of the lumen. As the process continues there comes a time when the intima is involved and destroyed, shutting off the vessel completely.

We discussed the use of cellophane with Dr. John Alexander. He raised the question of two possible objections, one being that the intense reaction might involve the recurrent laryngeal nerve which lies in juxtaposition to the ductus arteriosus. The question was discussed with him as to whether such a reaction could cause a permanent paralysis of the left vocal cord. The other objection was that the intense reaction and subsequent fibrosis might cause a permanent narrowing of the aorta. Neither of these mishaps occurred in our case but they should certainly be thought of as a possible complication.

SUMMARY

A case of patent ductus arteriosus in an adult woman, complicated by long standing severe subacute bacterial endocarditis and endarteritis is reported. The patent ductus arteriosus was occluded by ligating it with two silk ligatures and then wrapping cellophane loosely about it. The clinical postoperative course of the patient demonstrated the fact that the cellophane was responsible for the final complete occlusion of the patent ductus arteriosus. For the first two weeks the murmur and symptoms disappeared only to reappear and persist until two and one-half months had elapsed from the time of operation. The murmur and symptoms then completely disappeared and the patient has remained entirely well to date, one and one-half years after surgery. The cellophane was thought to be responsible for the final complete and permanent occlusion of the patent ductus arteriosus.*

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* Since this report was written the patient has given birth to a normal child. She had no trouble at the time of the delivery and has had no trouble since the delivery.

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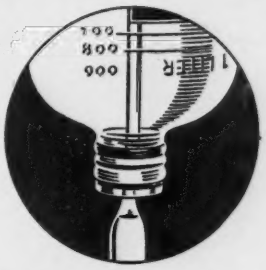

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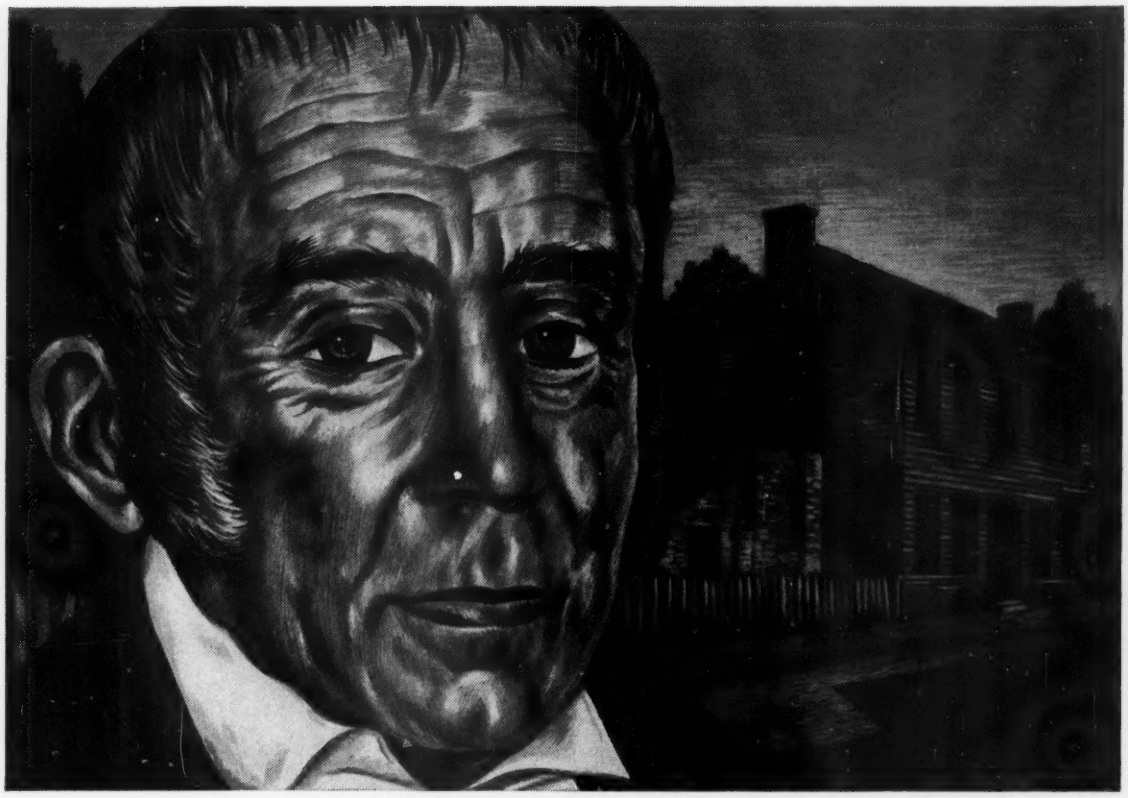

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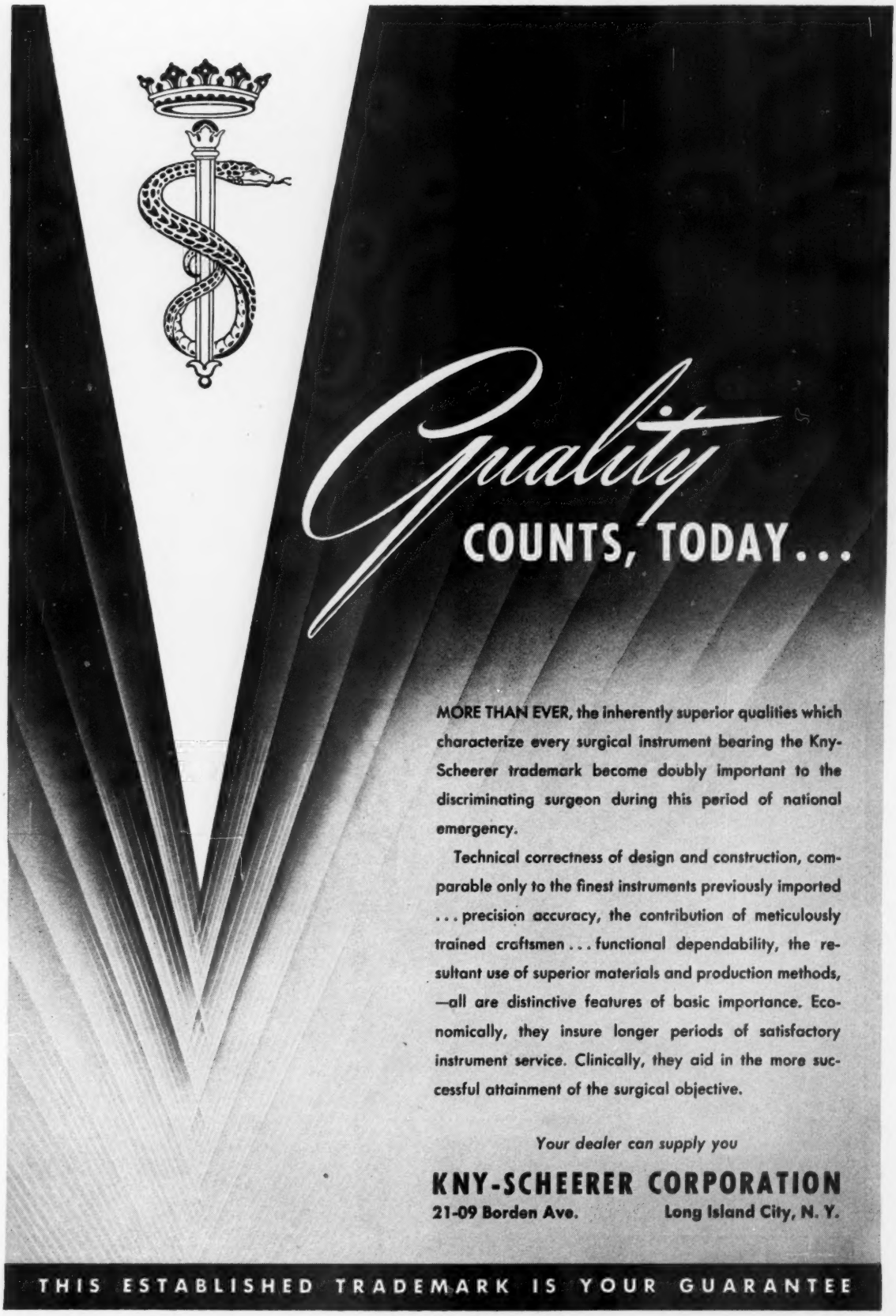
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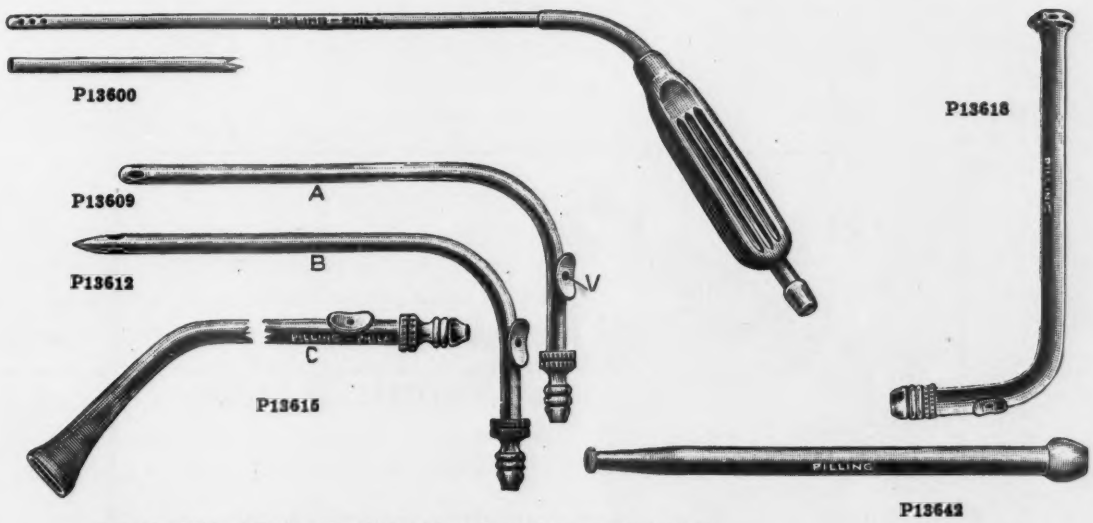

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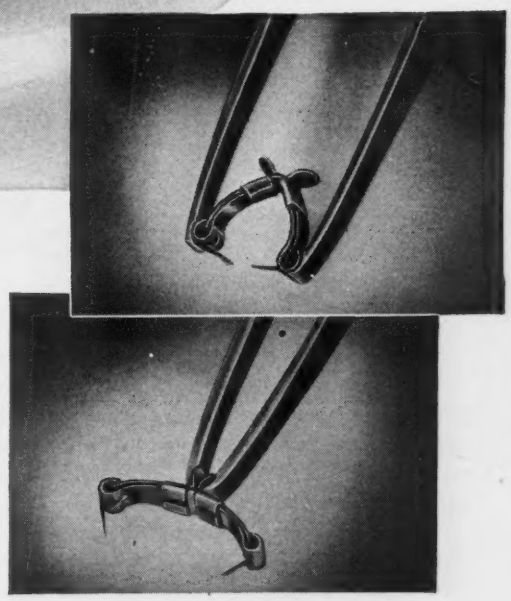

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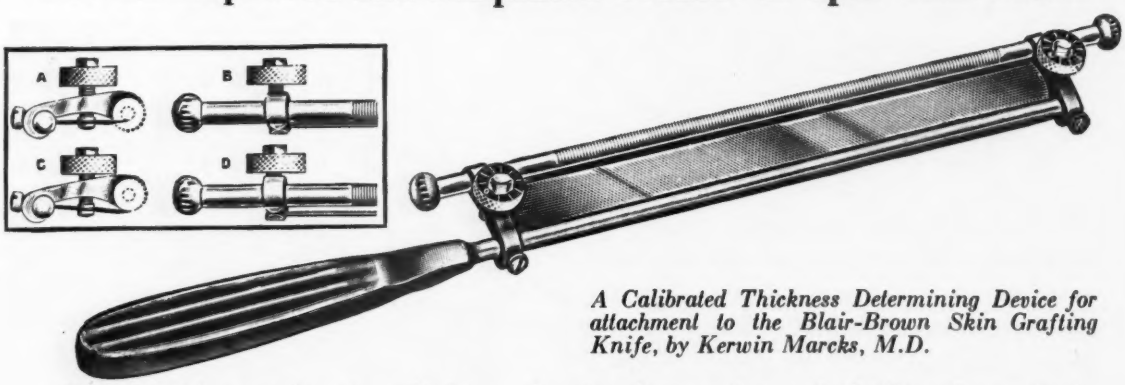

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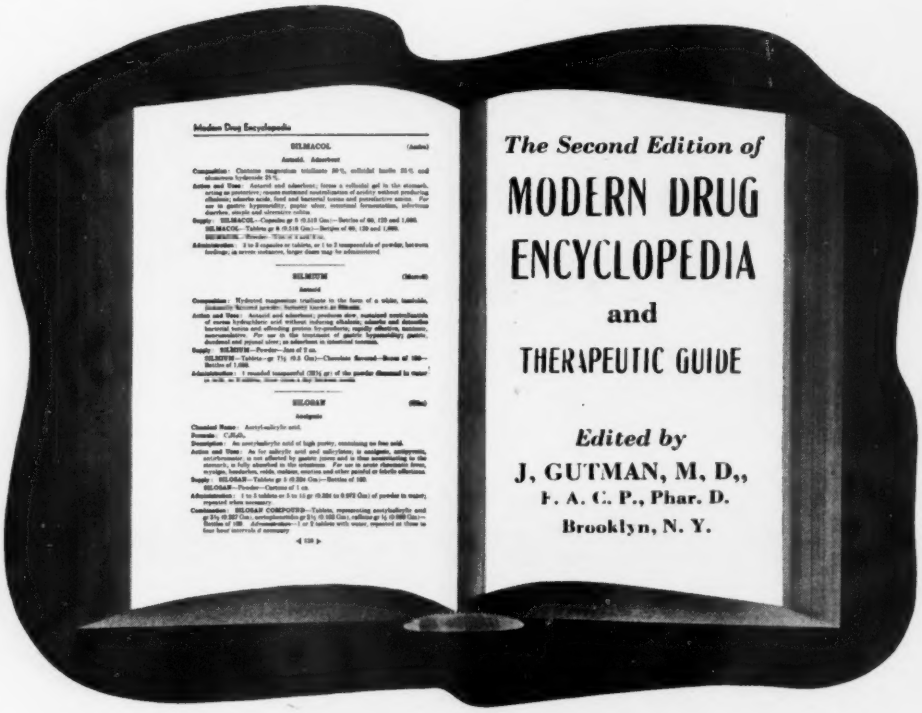

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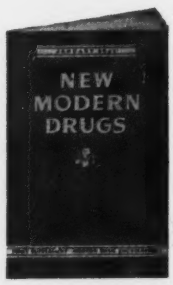

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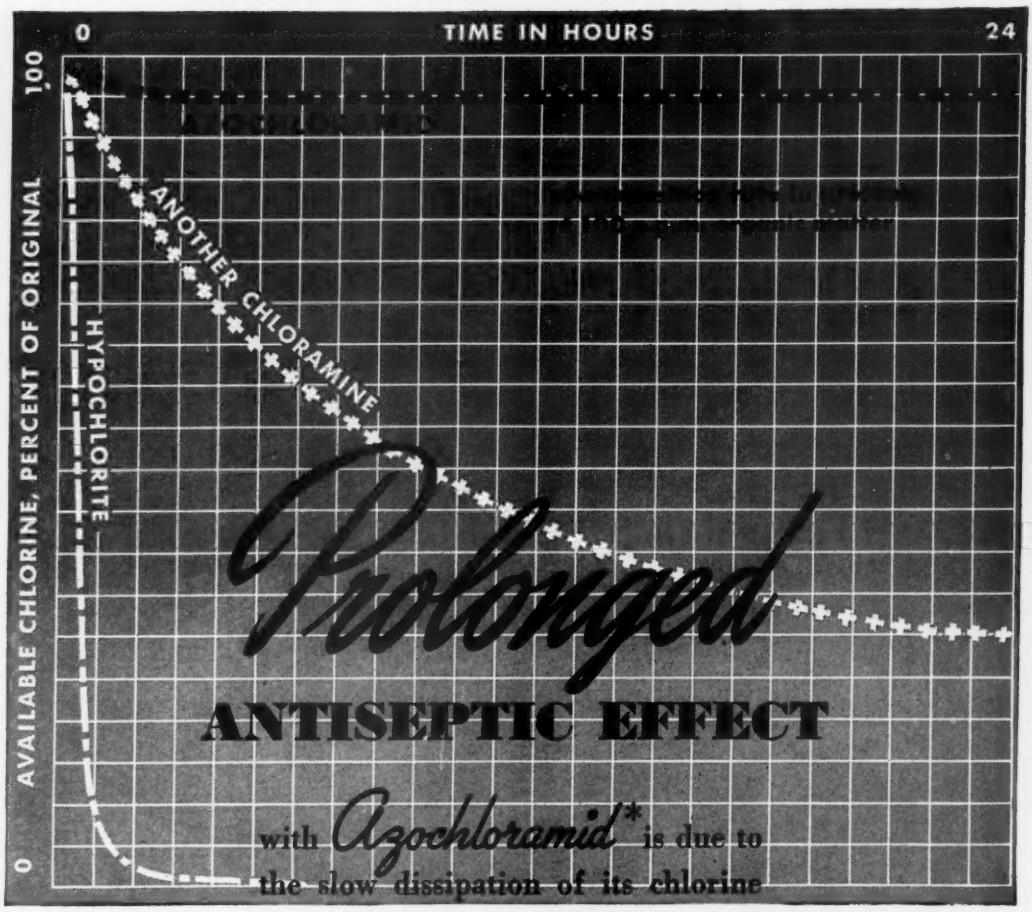

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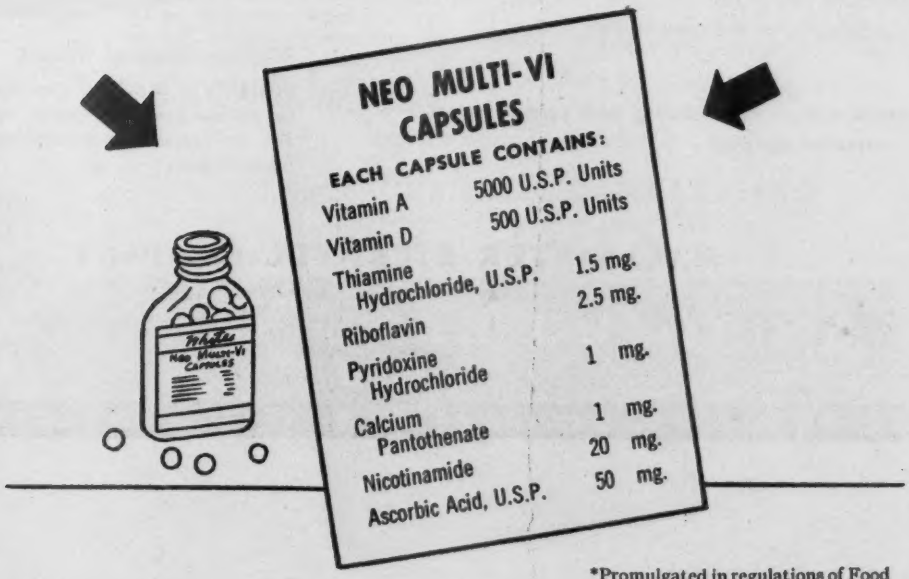

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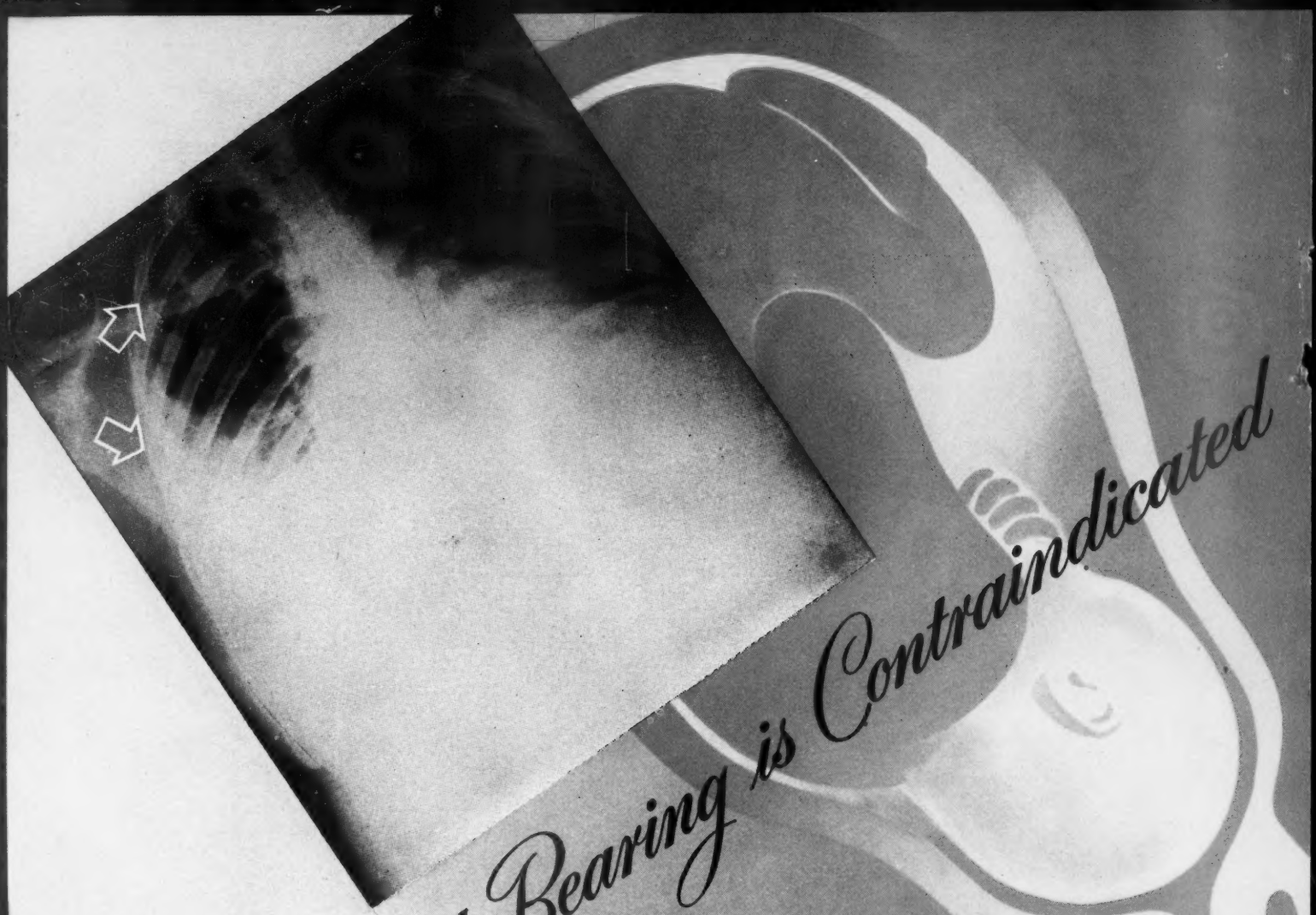

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[1] Clement, P.; Elder, C.: Anesthesiology, 4:516, 1943.

[2] Forsee, J.; Sheftz, L.; Berbank, B.; Fitzpatrick, L.; Barford, T.: J. Lab. & Clin. Med., 28:418, 1943.

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